ANTHROPOMETRY

AND

Physical Examination.

A BOOK

FOR PRACTICAL USE IN CONNECTION WITH GYMNASTIC WORK AND PHYSICAL EDUCATION.

BY

JAY W. SEAVER, A.M., M.D.,

Medical Examiner and Lecturer on Personal Hygiene in Yale University. Lecturer on Anatomy, Physiology and Anthropometry in the Chautauqua School of Physical Education. Ex-President of the American Association for the Advancement of Physical Education. Member of the Connecticut State Medical Society, etc.

NEW HAVEN, CONN.

1896.

PRESS OF THE O. A. DORMAN CO.,
NEW HAVEN, CONN.

CONTENTS.

CHAPTER I.

HISTORY OF ANTHROPOMETRY.

Its source in art.—Greek standards.—Roman and Egyptian canons.—German and modern art proportions.—Anthropological purpose.—Its methods.— Pedagogical purpose. 7–16

CHAPTER II.

RECORDS AND INSTRUMENTS.

Description of modern instruments.—The various books, cards, charts, etc., for general and private use.—What points should be noted. 17–34

CHAPTER III.

WHAT TO MEASURE AND HOW TO MEASURE.

The technique of measurement.— The personal element.— The official list of items and rules of the American Assoc. for the Adv. of Physical Education.— Criticisms and suggestions. 35–59

CHAPTER IV.

PERSONAL HISTORY AND EXAMINATION OF THE SPECIAL SENSES.

The private record.—Family history.—Importance of the sense organs.—Directions for examining the eye, ear, etc. . 60–70

CHAPTER V.

TESTS OF STRENGTH.

Importance for prescribing exercises.—The mercurial dynamometer.—Method of using.—Results obtained. . 71–82

CHAPTER VI.

SPECIAL INSTRUMENTS.

The pelvic obliquity and its measure.— Instruments.— The length of legs.—The deviations of the spine, etc. . 83–92

CHAPTER VII.

GRAPHIC ANTHROPOMETRY.

The tabulation of data.—Averages, means, percentages, etc. 93-116

CHAPTER VIII.

THE LAW OF GROWTH.

The increase in height and weight from birth to maturity, in males and females. 117–132

CHAPTER IX.

EXAMINATION BY INSPECTION.

Training the eye.—What is to be seen from the various aspects. —Table. 133–147

CHAPTER X.

EXAMINATION BY PALPATION.

Methods and results.—Normal and abnormal conditions.— Tumors. 148–153

CHAPTER XI.

EXAMINATION BY AUSCULTATION AND PERCUSSION.

Methods.—Areas.—Normal sounds of lungs, heart, etc.— Abnormal sounds. 154–167

CHAPTER XII.

THE SIGNIFICANCE OF CERTAIN PHYSICAL SIGNS.

Discussion of heart sounds.—Sphygmograms.—Table of heart sounds. 168–180

CHAPTER XIII.

PRESCRIPTION OF EXERCISE.

The standard of physique.—Respiratory inefficiency.—Neurasthenic cases.—Circulatory disturbances.—Prescription form. 181–194

CHAPTER XIV.

THE EXAMINER HIMSELF.

The need of physical training and the standard for the examiner.—Personal advice. 195–200

PREFACE.

The purpose of this book in its first edition was to place in the hands of directors of gymnasia, who were expected to examine people and prescribe exercise for them, a manual that should be a constant guide in securing measurements and an efficient help in pointing out the vital matters that should be considered in making a physical diagnosis, or an estimate of the organic condition of the various parts of the body and their habit of action.

The purpose of the present book is the same as that of the former edition. The failures of the last have been partly eliminated and the methods of measuring more carefully discussed and illustrated, as well as the tabulation and comparison of material.

The instruments for securing more exact data, especially in new lines of research, have been given more attention, as it is believed that the most valuable anthropometric work of the future will be done without attributing so much value to space relation or size. The important question will be, What can the human machine do? and not, How large are its various parts?

As an investigator in a new field of study who has already added much to our knowledge of the working power of the human body I mention Dr. J. H. Kellogg, to whom I am specially indebted for much new and valuable material. I wish also to acknowledge the many courtesies that I have received from other authorities who have permitted the use of material for which credit is given in the text.

YALE UNIVERSITY, NEW HAVEN, CONN.
JUNE, 1896.

CHAPTER I.

HISTORY OF ANTHROPOMETRY.

There can be no study of more interest than that which pertains to human life and development. It is the center around which all thought and all energy crystallizes. Youthful ambition, parental solicitude and mature counsel all aim at the elevation of life to a higher standard and more complete form; the child is to be better than the parent, the race is to evolve toward perfection.

The highest ideal of art has been to portray life in its most perfect form, whatever may have been the vehicle of the thought: stone, color, tone or word. The outward form and its action has also become the test of the inward man; the thoughts, the impulses, the feelings, are recognized as having a physical basis that can be measured in some way and thus serve as a partial guide to the possibilities and probabilities of the future. Psychology looks for its material in the physical data that can be gathered, and no longer has its roots in speculation and personal opinion but in physiology. A determination of the law of physical growth for the human animal has done more to correct educational methods than any other influence in pedagogy. Keen observation had made great teachers before but their method was never reduced to law. The nearest approach to this was the establishment of the Kindergarten by Froebel. But even here the establishment of the fact of a normal development of the control of fundamental muscles before the accessory has introduced vast improvement into the method.

We must study then to "know ourselves" physically if we are to train ourselves into the highest type of mental

development as well as into the perfection of health and bodily vigor. In studying the law of organic growth it became necessary to record in definite terms the changes that characterized the various periods of life, and measurements of size and weight were made. Thus the knowledge of modern human proportions has been derived from the measurements of living persons of all ages and of both sexes. For this process Quetelet coined the apt word—Anthropometry.

In considering the science of anthropometry it may be worth our while to glance somewhat briefly at its history. It is old as compared with other sciences, but it was developed primarily for purposes of art, rather than for those of physiology or anthropology; and art, which is said to be "the daughter of the imagination," did not consider originally the true proportions of the human body, but tried to represent an ideal that corresponded closely to the modern conventionalized forms, or so-called fashion. We see this in Egyptian art, where both hands were made right, and where a peculiar facial type is given which certainly did not represent the ordinary beautiful face of the race, but an idealized face. The development of art called for a closer adherence to the normal type of body, and probably the greatest incentive to imitate life came through the Greek admiration for the athlete, it being a law that the successful competitor at the Olympic games should have his statue carved in marble. The influence of this custom undoubtedly modified Greek art favorably, and brought it to the highest standard that sculpture has ever attained. We know that certain artists, who were celebrated for the excellence of their work, left as their masterpieces statues that undoubtedly represent victors at these games. Polycleitos is said to have made five statues of victors at Olympia, and a head of Hera that was "like a verse from Homer."

The study of human proportions as related to art expression was carried to a high degree of perfection by Polycleitos, who, after mature study, sought to fashion a model that represented the ideal man. While this statue, called the Doryphoros or Spear Thrower, has been lost, undoubted copies of it in fair condition of preservation are extant.*

The Doryphoros, "*viriliter puer*," was, in intent and by general consent, the representation of absolute perfection in human proportion. It was the canon followed by succeeding schools in portraying the highly developed figures while the companion figure, the Diadoumenos, "*molliter juvenis*," constructed on the same proportions of length became the model of younger types. As a result of his minute study of human proportions this artist left a large number of statues, all of which are considered by art critics to be of a high standard of excellence.

The Roman sculptors to a certain extent followed the Greek canons, and at the same time developed original lines of thought in connection with human proportions. We do not know, however, that they derived these ideals from many measurements of proportion, but have reason to believe that they were the result of the study of graceful forms and of ripened judgment in regard to physical beauty. The table of proportions given by Vitruvius does not give evidence of actual measurements taken and compiled but he probably drew on older canons—the Egyptian or the Greek.

Among more modern artists the same effort to secure some law of proportion, that should apply to all artistic productions, has been made, and with comparatively little advance from ancient canons. The failure in these

---

*See Reber's "History of Art," Waldstein's "Essays on the Art of Pheidias," Collignon's "Histoire de la Sculpture Grecque," and Sybel's "Weltgeschichte der Kunst."

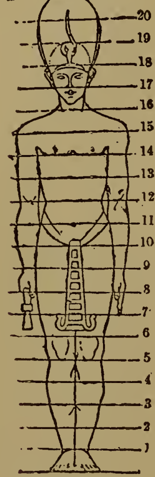


Fig. 1.

methods has been from the attempt to find some one part of the body that should be a common measure of all the other parts; as in the ancient Egyptian canon (Fig. 1), where the length of the middle finger was considered a common measure of all the other proportions, five fingers being the height of the knee, ten fingers the height of the pubic arch, eight fingers the length of the arm to the tip of the fingers, three fingers being the length of the head and neck, and the total height being nineteen fingers.

The physiologist Carus, of Dresden, conceived the vertebral column to be the unit of measure and this he divided into twenty-four parts, according to the number of vertebræ, assigning to each the same value, as in embryonic life.

The great German artist, Albert Dürer, of Nuremberg, worked on a canon of proportion, considering the total height to be unity. The length of foot was one-sixth of this total, the head one-seventh, the hand one-tenth, etc. Dürer made the ratio of height between men and women as 17 to 18, while among English people the ratio is as 12 to 13. This showed his method to be that of the artist rather than of the anthropologist. The artist Schadow of Berlin, saw the failure of Dürer's canon and drew up tables of proportions derived by averaging the measures of various models, carrying the investigation to the time of birth.

Later artists have in general endeavored to follow the classic canons or to educe a new modulus after the Egyptian type and perhaps the most successful effort toward this end has been that of Story, whose method is

based on the mathematical relation of certain geometric figures.

In the early half of the present century the strong trend of study toward the *natural sciences* led to the more thorough investigation of the natural history of mankind, and we find that more or less valuable treatises were published on anthropology. This gave a new impulse to the study of human proportions, for in studying different races of men it was found that they had marked peculiarities of physique, as well as marked mental peculiarities and customs. In 1870 Quetelet, who was at this time director of the Royal Observatory at Brussels, and a leading mathematician of his day, conceived the idea of assisting anthropology in its classification of human races by the determination of their physical proportions, believing that each race had such peculiarities as should constantly serve as a means of identification. He began this work with much zeal, and soon found that it had a much broader scope than he anticipated when he began his research. He writes in the first chapter of his book on anthropometry that he is appalled by the magnitude of the field of research into which he has entered. However, being accustomed to deal with numbers, and having the enthusiasm of the true scientist, he proceeded in his work, and has given valuable material for all students of anthropology and anthropometry since his day. He was the first investigator to apply purely mathematical methods in determining the physical constants of the human body, and he demonstrated the "law of chance" as applied to human proportions. This so-called law of chance, or probability, has been found to be true in its general application. It has been made the basis of more recent investigations, and has been specially applied in graphically representing the racial type; as, for instance, in the representation of the difference

between tall and short races, as the Patagonian Indian and the Chinese. After establishing this law as applied to his own countrymen, he endeavored to determine the physical constants of other races, and perhaps the only criticism that can be made of his work is that he sometimes drew conclusions from insufficient data. For instance, in determining the size of the American Indian, he concluded from the measurement of a few specimens that were on exhibition in Brussels that the Indian is of excessive height and size as compared with the ordinary European—which conclusion has been found by more recent investigators to be not in accordance with the facts. He did determine the fact that various races follow special laws in their growth and development, as do the various organs, and the discovery of this fact has led to important results, not only in anthropology but in physiology, as we find that those types having comparatively long trunks and short limbs possess higher resisting power than the opposite types. We also find that the size of certain physical organs, like the chest, has a direct relation to the working power of the individual when considered as a machine. The relation of total size to the respiratory power is an important physiological factor, as is also the relative length of different levers when the adaptability of the individual for special occupations is considered. It may be said that in more recent years the incentive to anthropometrical investigation has not lain in artistic or anthropological lines, but in pedagogical, psychological and hygienic.

By far the greater part of anthropometrical work that has been done in the last twenty-five years has been done in connection with educational institutions and for educational purposes, and it may be truly said to-day that the investigators who are most active are the ones connected with departments of psychological study. The

reason for this may be clearly seen in the fact that the racial type having been considered, the study of the individual for the sake of bringing him up to a high degree of excellence becomes the next important duty of the educator. In this country especially it may be said that the work has tended in this particular line, while in England the research has been devoted to such departments as tend to the determination of general anthropological laws. In 1884 Francis Galton established in connection with the Health Exposition of London a bureau of anthropometry, for the purpose of gathering material that should determine the physical constants of English men and women, and serve as a check on work done before on the Continent, and that might possibly lead to the discovery of new laws. A preparation for this work had been made by Charles Roberts of London when, in 1878, as secretary of the British Association for the Advancement of Science, he published the report of the Committee on Anthropometry, and presented some interesting material gathered by himself. The material gathered by Mr. Galton was extensive and was studied by a new method, which has been quite generally adopted during the last fifteen years and which has a high utility in showing the distribution of proportions. His plan, in brief, was to group all the measurements of any particular item, as height or weight, into percentile groups, or into such groups as could be represented by integral parts of one hundred. These measurements being grouped in this particular way made a determination of the mean easy (*l'homme moyen de Quetelet*), and showed that the proportions, when so grouped, followed Quetelet's binomial law of chance. This method enabled him to say of any given individual that he excelled a certain percentage of other persons, or that he was excelled by such a percentage of individuals in any item recorded.

This, therefore, became a valuable method of graphically representing the size of any person, for, after having determined the distribution of the sizes of any particular item, the position of the individual in this distribution was easily determined. If, then, we group all the items of measurement of a similar class of persons, according to the percentile form, and have a table prepared that shows this distribution, we have an easy form of graphic representation. This method has been followed out most completely in this country as applied to the student classes of the community, no one as yet having undertaken the general measurements planned by Galton in England. The nearest approach to this English standard for mature individuals is probably found in Gould's Sanitary Commission Memoirs, gathered from recruits who were examined during the Civil War. This memoir is a fairly comprehensive study of the actual and relative proportions of over a million men between the ages of sixteen and forty-five years.

In our educational institutions we have largely followed the example set by Dr. Hitchcock of Amherst thirty-five years ago, in making a physical examination of the students who were admitted to the gymnasia connected with our colleges. In connection with this physical examination a measurement of some of the more important items has been made. This method has resulted so satisfactorily that it is now applied, not only to the students of the leading colleges and universities throughout the land, but in very many of the better class of secondary and private schools. This work has also been extended by the investigations of persons who have been interested in physiological or experimental psychology, and large numbers of school children of various ages have been measured and tested in order to determine, so far as possible, what relation might exist between physical con-

dition and intellectual activity. Tables representing these investigations will be found in another part of this volume.

In this connection we must mention the very thorough study of the growth of American school children made by Dr. Bowditch in 1877. The result of his investigations determined for the first time the law of growth for Anglo-Saxon children between the ages of five and sixteen years. This investigation had been preceded by a somewhat similar one, made by Dr. Fahrner of Zurich, Switzerland,* although his results never received the attention accorded to the work of Dr. Bowditch, because that of the latter was far superior in accuracy and extent. Dr. Geo. W. Peckham of Milwaukee, Wis., in 1880–83, made a study of the growth of school children, and a like investigation has been made in 1892–93, by Dr. W. T. Porter, upon children in the public schools of St. Louis, Mo., which confirmed the conclusions of Dr. Bowditch and established several new facts pertaining to the physical and mental growth of children.

In 1893–4 Dr. E. M. Hartwell made a study of the relation of the nervous phenomenon of stuttering to growth and to the "specific intensity of life," among the school children of Boston.† The term specific intensity of life is used to express the ratio between the number of children living at any age and the number dying at that age. Incidentally he demonstrated the direct relation between the specific intensity of life and acceleration of growth.

The study of the nervous phenomena of school life and its relation to growth has been most thoroughly planned by President Hall of Clark University, and the results so far as published have given a basis for a critical discussion

---

* Das Kind and der Schultisch.

† School Document, No. 8, 1894, Boston.

of pedagogical systems that is already bearing fruit. In the same field of inquiry are found some papers by Dr. E. W. Scripture* of Yale, and Dr. J. Allen Gilbert.†

Dr. G. W. Fitz of Harvard has also called attention to some of the nerve reactions that help to declare the condition of a person,‡ and has invented some instruments that record the time of reactions. In foreign countries the study of physical data obtained by anthropometric tests has been carried to a high degree of perfection along physiological lines. Axel Key of Sweden has studied the relation of growth to temperature and climate, as marked by the seasons of the year, and to the pubertal period. Bertillon and Demeny of France, Mosso and Livi of Italy, Schmidt and Voigt of Germany, and many others have made additions to our knowledge of the human body and its development. The problems of the future will lie in a determination of the influences affecting the neuro-muscular mechanism and its dominating center, the intellect; the exact values of heredity and nurture as the determining factors of a large part of life; and the evolving of a pedagogical system that shall train the young to the highest possibilities of their faculties.

---

* Ninth Annual Report Am. Assc. for Adv. of Phys. Education.

† Studies from the Yale Psychological Laboratory, Vol. II.

‡ Tenth Annual Report Am. Asso. for Adv. of Phys. Education.

CHAPTER II.

THE RECORDS TO BE KEPT AND THE INSTRUMENTS TO BE USED.

For taking the measures of a person several instruments are needed; but the outfit may be very simple. For several reasons the record should be taken and kept in the metric system: 1st. It is the scientific standard in use in all countries, and is in use in every other department of scientific investigation. 2d. It enables one to be very accurate without trouble, as the unit is very nearly one twenty-fifth of an inch. 3d. There are no fractions to complicate compilation or computations, or records. 4th. It helps to introduce an improved system of weights and measures into general use, and, as the ordinary person has no idea whether his record in English units is large or small, but only judges by comparison with the standard, he will get as good an idea by the metric system as by any other.

The record book should be made of the best ledger paper and ruled transversely into spaces enough for all the items to be recorded. The perpendicular ruling can be made to divide the space into six columns, for the records when measurements are repeated. This will enable one to see at a glance what the change has been in any item, from time to time. If the space is economized, there will be plenty of room on the two pages that face together to record the measures of three individuals, six times each, and keep such items of history as should appear in such a book. The list of items recorded will be seen on page 95.

It is advisable for each examiner to keep a private book for containing information of a purely personal nature, and for the guidance of the instructor in prescribing exercise. This private record will give him an amount of material for study and comparison in a few years.

The books should be bound in volumes of about one hundred and fifty leaves, with heavy leather, as they are handled frequently. A second way of keeping the records, that has advantages in compiling the figures, or tabulating, has been devised by Dr. Swain. It consists of a card, with all the items, and room for two records of measurements. These cards are simply filed in alphabetical order and kept for reference. In tabulating results they are sorted over and placed in piles, according to any standard that may be taken, as height or weight, etc. It is not a desirable form for a permanent record but, as the personal property of the examiner, is preferable to a book.

In the form of record book devised by Dr. Gulick for use in Y. M. C. A. work, the historical data are placed at the top third of the page, the remainder being divided into a column for prescription, and several narrow columns for measures. The number of items measured is smaller than the list prescribed by the American Association for the Advancement of Physical Education.

It would seem that the card system of record could be used profitably in Y. M. C. A. work, as there is no special reason for permanently keeping the data except at some central bureau, where they can be tabulated for scientific purposes. In schools and colleges a permanent record is very important for history and comparison.

A method of duplicating a record for the benefit of the person measured has been suggested by Dr. E. Hitchcock, Jr., in connection with his graphic chart described later, and consists of a duplicate page to be inserted

under the record page with a sheet of carbon paper between. By writing the record with a stiff pen the figures are duplicated on the chart page.

Another very satisfactory method of recording measures is by the author's anthropometric table bound in book form, and the measures indicated on it by dots and lines; or the actual record can be written at top or bottom and the graphic indications marked afterward. This gives a person looking over the record for special cases a comprehensive knowledge of the special form of the subject at a glance, where the examination of a list of measures even by an expert would be long and unsatisfactory. On the back is printed the following blank for historical data and a complete report on the physical conditions not capable of size relations. There is also abundant room for notes on the further development of the case, and the special exercises prescribed.

Name, ...
Birthplace, ... Date of birth, ...
" of Father, ...
" " Mother, ...
" " Paternal Grandfather, ...
" " " Grandmother, ...
" " Maternal Grandfather, ...
" " " Grandmother, ...
Occupation of Father, ...
Father died of ... .
Mother " " ....
Common diseases in family, ...
Resembles in physical build, Father's Mother's family, ...
Accidents and surgical operations, ...
Diseases, ...
Condition of eyes, ... Vision, $\frac{\text{R. E.}}{\text{L. E.}}$ .... color-blind, ...
" " ears, ... hearing, ... nose, ...
" " muscles, ...
" " digestive organs, ... bowels, ...
" " kidneys, ... skin, ...
" " lungs, ...

Condition of heart,.................... pulse,......................
" " nervous system,..............sleeps,.................
" " spine,..
" " shoulders,......................legs,. ....
Previous work or exercise,...
" health,..................... ....
Color of hair,...
" " eyes,... ....
Use of tobacco,...
Notes,...... ....
....

A card containing blanks to be filled with the historical matter by the person to be examined saves much time for the examiner and should always be used. The following form is serviceable:

Mr............................. ....
Your appointment for examination is..................
at..............M., at room..................Gymnasium. Please fill out this blank and bring with you at that time.

The data here given will be considered strictly private, and will be retained by Dr...
Name in full................................ ....
Date of birth.... ....18.......
Birthplace of Self, Town.........................State............
" " Father, State...
" " Mother, " ....
" " Father's father, State.............................
" " Father's mother, " ....
" " Mother's father, " ....
" " Mother's mother, " ....
Father's occupation...
Do you most resemble your father's or mother's family in physical build?.. ....
If either parent is dead, of what did father die?......................
Of what did mother die?...
State any illness that has been common in the family, due to diseases, as follows:

Heart... ....Lungs...................
Digestive organs... ....Skin..................
Kidneys....................Nervous system..................
Scrofula...................... Rheumatism....................
Defective vision............or physical peculiarity.............

Have you ever had any illness that confined you to the bed for two weeks, or more ?..............What ?..........................
Have you ever had trouble with the eyes ?........or ears ?.........
Can you breathe freely through each nostril ?... ....
Is your digestion good ?..................Are you ever troubled with bilious attacks ? .... or with constipation ?............. or chronic diarrhœa ?................
Is a cold more likely to locate in your nose, throat or lungs ?.........
Do you suffer from nasal catarrh ?............
Do you faint easily ?............
Have you ever had palpitation of the heart ?............
Do you suffer from cold feet or hands ?............
Do you suffer from headaches ?............
Do you sleep well ?............How many hours ?............

This private book should contain a careful record of personal peculiarities that may have a bearing on health and development. Any history of previous disease or accidental injury, even if recovery seems complete, should be recorded. Advice in regard to exercise and the results of the advice should be noted. This book should be a history of the person's physical welfare during the past and while he is under observation, and thus correspond to a physician's case-book. The examiner will learn more from this record than from the book recording size and strength, when he studies the result of gymnastics.

The following instruments are needed for measuring:

1. A set of scales, with high bar for convenience in reading. These are made with metric graduation (Fig 2).

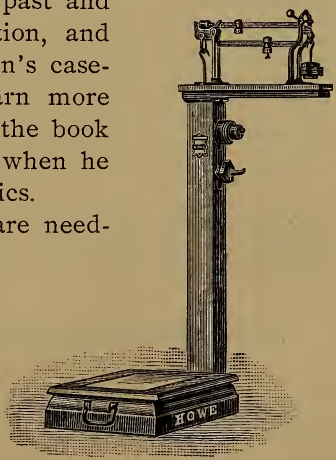


Fig. 2.

2. A graduated pole, with a slide moving at

right angles on it for taking heights (Fig. 3).

The arm of the slide should not be over 125 mm. long. The pole may have the metric system marked on one side, and the English on the other, like the one shown in the cut.

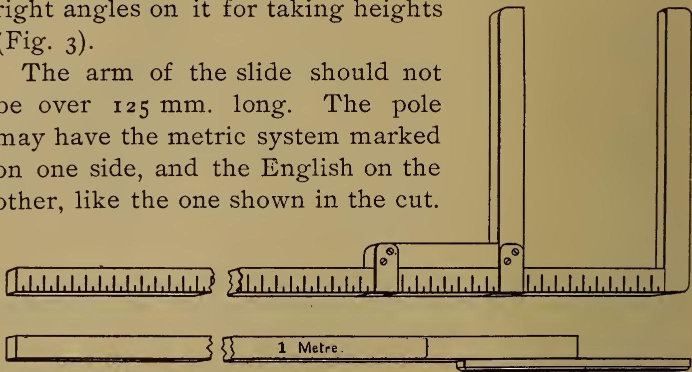


FIG. 3.

It is essentially two meter sticks, on one of which is fixed at the end an arm 125 mm. long, at right angles to it. A slide bearing a similar arm is made to run closely on the stick. The height is readily taken by holding the ends of the sticks together by the left hand while the right lowers the slide to the top of the head. Care must be taken to have the sticks perpendicular. The height sitting and the height of pubes and knee are taken with the one stick, which is much lighter and more readily handled than a long pole. The same stick, with slide, can then be used for taking the breadths.

3. A pair of slide calipers (Fig. 4), for taking breadths, will be needed if a pole is used for

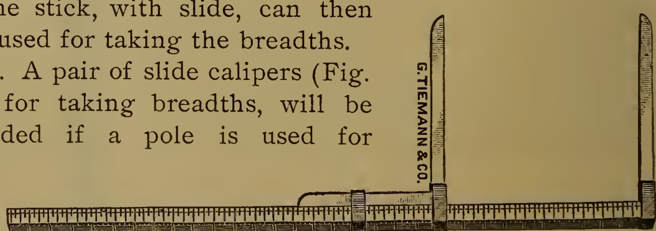


FIG. 4.

heights different from the one described. This adds to the expense as well as to the number of articles to be handled.

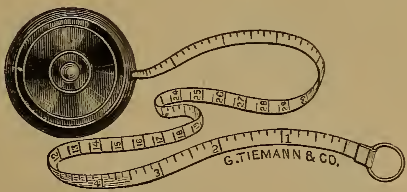


FIG. 5.

4. A tape measure of steel (Fig. 5), or cotton (Fig. 6). The metal is uncomfortable to the skin, but does not stretch and can be kept clean. A linen tape stretches on being moistened, and many subjects will sweat so freely as to wet a cloth tape. A painted tape is about as unpleasant to the touch as one of steel. A tape must be renewed often and as the cotton tapes are inexpensive they are a very desirable form for general use.

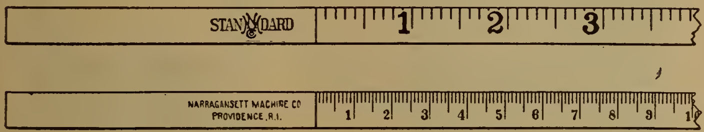


FIG. 6.

A little instrument is made by the Narragansett Machine Co., at the suggestion of Dr. Gulick, for attachment to the end of a tape to indicate the proper tension, so that the pressure may be always alike (Fig. 7). It is a good device for the beginner, but useless after practice has given a habit in making the tension.

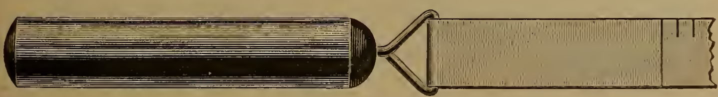


FIG. 7.

5. Calipers for taking depths (Fig. 8). These may be of wood or metal and should have large extremities, so that a slight variation in pressure will not vary the record greatly by indenting the flesh. An index should be

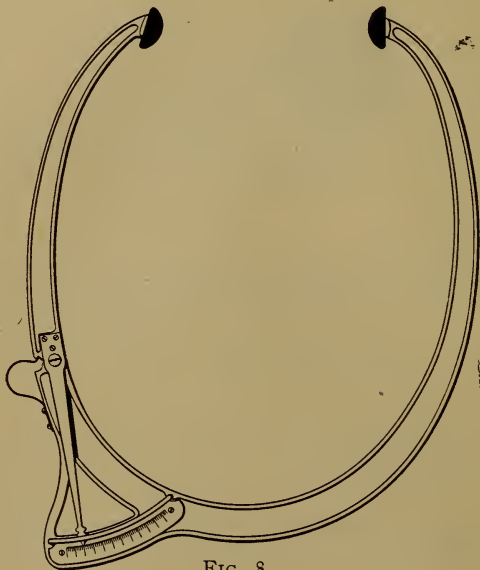


Fig. 8.

on the instrument, for reading while in position and a spring should give a constant pressure while the instrument is being used.

6. A capacity spirometer (Fig. 9), for recording the amount of air that can be inhaled and then exhaled, or the complemental, tidal, and supplemental air of respiration. Hutchinson's wet spirometer is considered the most reliable instrument of the kind (Fig. 10). It is made in various forms and should record the capacity in liters.

7. A stethometer or pressure spirometer is used by some persons, but is utterly worthless as far as information elicited by it is concerned. A person may blow by means of a rubber tube and suitable mouthpiece into an ordinary steam gauge that is made for recording low pressures, or an instrument devised by the author may be used. A piece of glass tubing of 5 mm. diameter is bent into the form of a right-angled triangle, having one angle of about 35°. The side adjacent to this angle should be about 400 mm. long and should be horizontal when the triangle is fixed against a flat wall for support. A rubber tube with a glass mouthpiece is attached to

the short side, and mercury is drawn in to fill the horizontal part. Now, by blowing into the mouthpiece, the mercury is forced up the hypothenuse of the triangle.

The graduation is easily made by measuring the perpendicular line from the base to any point in the hypothenuse, and affixing a scale to the support back of the tube. The pressure will then be indicated in millimeters of mercury column.

FIG. 9.

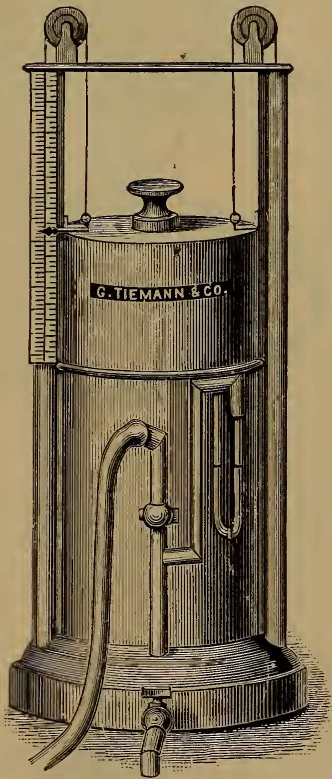
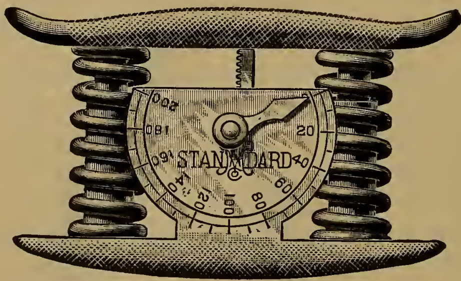


FIG. 10.

8. A hand dynamometer (Fig. 11), for taking the strength of the flexor muscles of the forearm may be used where a universal mercurial dynamometer is not available.



COPYRIGHT 1891 BY N. M. CO.

Fig. 11.

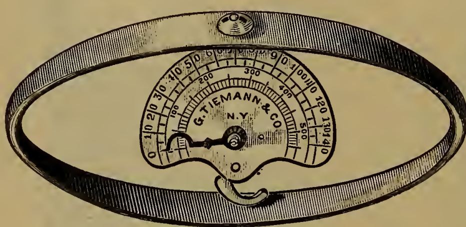


Fig. 12.

There are several forms of this instrument, the more common ones being the oval (Fig. 12), and the form with the two sides always parallel (Fig. 11), the resistance being two spiral springs. This second form gives all the fingers an equal opportunity to exert their pressure. A "push holder" (Fig. 13), and a "pull holder" (Fig. 14), are made to use with the oval instrument for enlarging its range of utility.

9. A dynamometer for lifting with the back and legs, and taking the strength of the pectorals and retractors of the shoulders is shown in Fig. 15. The instrument may be replaced for the first two tests by a lifting machine with spiral spring resistance,

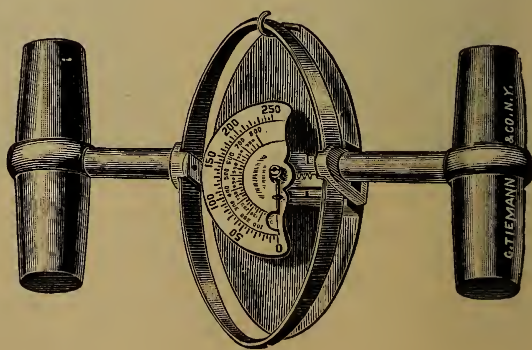


Fig. 13.

and a graduated index applied from actual tests. The advantage of this latter form is the quick adjustment to the height of the person.

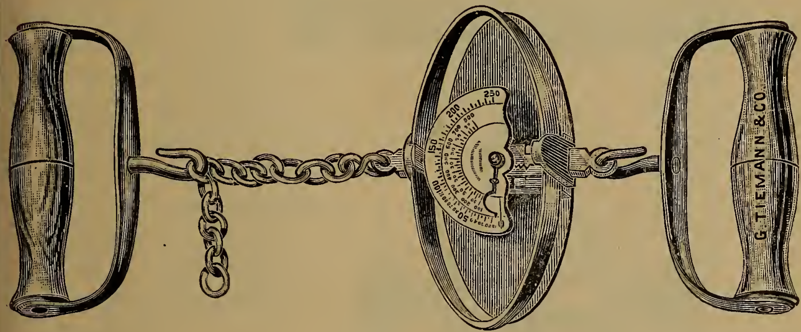


FIG. 14.

10. Parallel bars for testing arm extensors in "Push up." A short pair of bars (Fig. 16), about 750 mm. long, attached to a frame with suitable braces, and made to move up and down against the wall, in being adjusted to any height desired, can be used for this test and also for the "Pull up," or test of flexors of the upper arm. Otherwise a horizontal bar, trapeze bar, or pair of swing rings must be used for this last test. This bar frame should be hung with a counter weight and latch for easy and quick adjustment to any height.

11. A stethoscope for listening to heart and lung sounds, etc. (Fig. 17). Camman's binaural is a suitable instrument. The soft rubber bell, B, is useful at times to secure perfect coaptation to the surface of the chest. It requires some practice to secure all the advantages that a stethoscope can give, as the pressure of the nib in the ear is a distraction of the attention, and any slight movement of the fingers on the instrument causes vibrations that are not understood. If the examiner wishes to hear the valvular sounds of the heart, without the

interference of muscular vibration sounds, he can interpose a thin cloth between the bell and skin, but in general the instrument should be placed directly against the surface of the body.

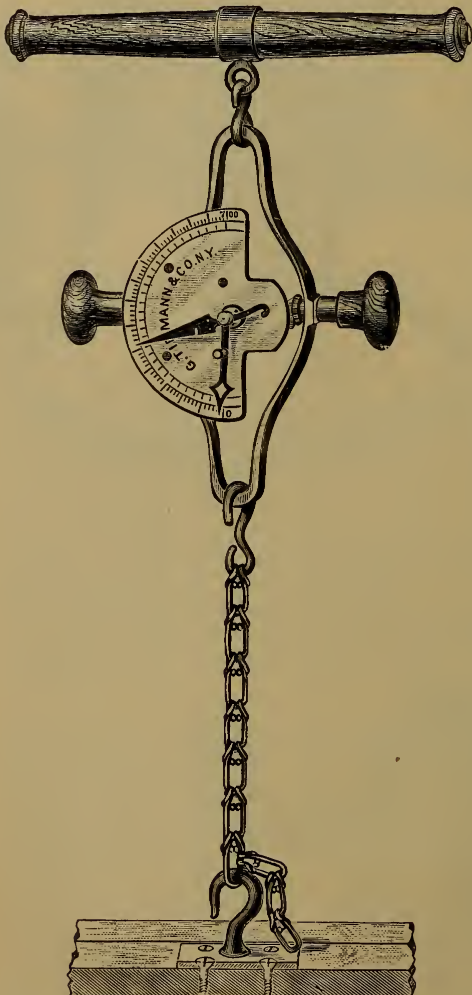


Fig. 15.

The Albion Stethoscope (Fig. 18) is considered by many prominent teachers in physical diagnosis superior to Camman's in some respects, and more desirable because it can be conveniently carried in the pocket without detaching the tubing.

In addition to the above mentioned instruments the following are useful at times and for special work:

12. A sphygmograph, or kymograph, for taking pulse tracings. Dudgeon's instrument is perhaps as satisfactory as

any. It is small, easily applied, can be carried in the pocket and used in the gymnasium as well as in the office. It cannot be applied to all pulsating surfaces. Marey's instrument is used to some extent, but the pneumatic kymograph is employed in all physiological laboratories, and does very satisfactory work.

13. A laryngoscope, rhinoscope, otoscope and tuning fork, for examining the throat, nose and ears.

14. A Clinical thermometer.

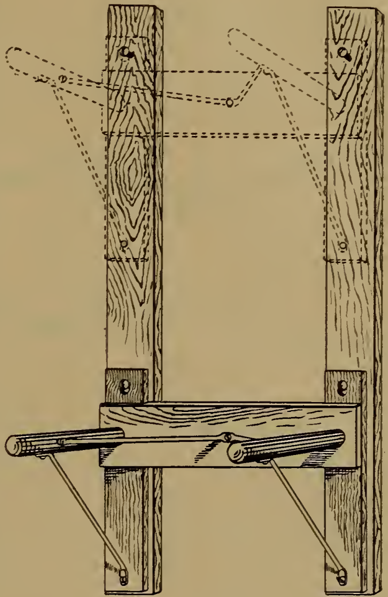


FIG. 16.

15. A Pleximeter and Percussor (Figs. 19 and 20).

16. A Microscope of 20 mm. focal distance for examining the skin.

17. A case of urinary tests for sugar and albumen.

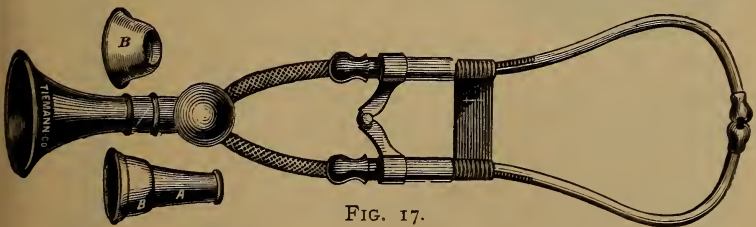


FIG. 17.

18. Test worsteds, glasses and charts, for examination of eyes for color blindness and errors of refraction.

These instruments can be obtained of any first-class dealer in surgical instruments and optical goods except 17, which can be obtained of Parke, Davis & Co., or other manufacturing chemists and druggists.

FIG. 18.

The historical data that should be gathered at each examination are of varied character, and of the highest importance. It not only gives the examiner an idea of the immediate weaknesses that are to be met and combated by proper advice and training, but it places the law of heredity in bold relief, and enables the counsel to be far-reaching in its results.

For instance: with a record of tuberculosis, extending through two or more generations, there would seem to be sufficient warrant for advising not only the thorough development of the chest, but the careful avoidance of excessive exercise, such as would be required in many athletic sports that would seem, at first thought especially suitable for a person of consumptive diathesis. To know a man well you must know his father and grandfather.

FIG. 19.

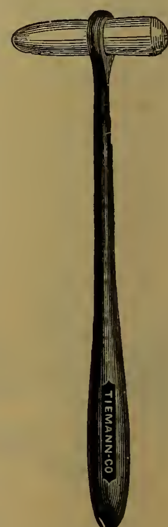


FIG. 20.

Growth and organic perfection are gained only by a use of all the tissues—but use is one thing and abuse quite another. The eye is developed and improved by a repeated use in distinguishing colors, shapes and sizes; but a long-continued strain of the eyes over a Greek or German text is not exactly beneficial, as the spectacle-mounted noses of our students, especially the Germans, bear witness. So, while a good run in the open air may be beneficial to a person of sensitive or weakened lung tissue, it does not follow that training for a mile run or a "hare-and-hounds" chase would be.

The condition of the subject during the previous years of his life is valuable in making a prognosis or a judgment of the future history of the case, and in deciding what quality of endurance the subject possesses, for the violent exercise of one man is a mere nothing for another. The boy who comes to school from the farm or workshop may be no better developed than his classmate who has never known what physical work is, and yet be able to endure twice as much prolonged physical exertion. His life has been spent out of doors, and he takes kindly to out-door sports, running, foot-ball, boating, etc.; or, if his life has been in a shop where skilled manipulation has engaged his energy, he prefers gymnastic exercises, becomes an adept at club swinging, fencing, etc., or a good performer on the bars, rings and other apparatus.

The city-bred boy has a latent aptitude for anything, and with proper training is a strong competitor with his country classmate in every line of athletics or gymnastics, but his exercise will need to be progressive or he will suffer from local strains that may affect vital organs.

If, on the other hand, the history discloses a previous life of activity and physical hardship, and the plan of life is directed toward sedentary pursuits, the recommen-

dation must be toward retrogressive exercise. A man with benign hypertrophy of the heart is not in the best condition for sitting at a desk all day—there will be too much local congestion for good brain work, or the metamorphosis of muscular tissue in the heart itself will end in fatty degeneration, or softening, and impaired vitality result. This is undoubtedly the reason for the numerous cases of functional and organic diseases of the heart that are found among ex-champions.

The history may also disclose a tendency to disease in the subject that will modify the prescription of exercise very materially, if the examiner is alive to the exigencies of the case and informed as to its requirements.

On the record book, in connection with the measures, the subject's name and birthplace should be kept—there is no reason for secrecy about these matters. It is also well to add the birthplace of parents and grandparents to this general record, for it makes the material valuable in studying the effect of location or environment in differentiating classes or social groups; the occupation of the father, the resemblance in physical build to father's or mother's family; past exercise in work and recreation, pulse rate, color of hair and eyes, vision and hearing, use of tobacco and stimulants. In the private book should be recorded the cause of death of either parent if not living, any disease that has been common in the family (it is better not to use the word hereditary in this connection), such as lung diseases, heart diseases, rheumatism, neuroses, Bright's disease, cancer, scrofula, varicose veins, dyspepsia, diarrhœa, constipation, catarrh, etc.; also any disease that may be found affecting the subject, as varicocele, rheumatism, synovitis, etc., any deformity and its cause, if discoverable; any injury in the way of broken bones, surgical operations, strains, etc.; any previous severe illness, such as peritonitis, zymotic fevers, etc.;

any tendency to deranged functional activity, as constipation, biliousness, indigestion, insomnia, etc.

In this connection it may be well to call attention to the rule that, if a child strongly resembles in physical build the side of the family that has no hereditary taint, the other side having some pathological diathesis or dyscrasia, the probability of his inheriting the disease is diminished.

It is well to record the special kind of athletic or gymnastic work that has been taken and whether this has been under the personal direction of a teacher or trainer.

If there is any lesion of the heart or other organs that has been due to or been attributed to athletic or gymnastic work under supervision, look up the instructor and get the previous history of the case. You may find that the so-called instructor or trainer was an ex-prize fighter or dilapidated "bummer," but, if so, use him to discredit the popular trust in ignorance. If he does know his business, he will perhaps be able to enlighten you as to the cause of the trouble.

It would seem to be desirable to establish some general system of marking physical condition so that a man who had been properly examined could have a statement, in such common terms as could be understood by lay people anywhere, that should give his condition of health, the important items of his size, the condition of all his so-called vital organs, his strength and apparent working capacity as well as his probability of life. Francis Galton has called attention to this desideratum in a communication to the American Association for the Advancement of Physical Education (see report 1891). I believe this to be a perfectly feasible matter and would suggest in connection with a graphic and numerical statement of size that there be a more extended system of strength tests.

An arbitrary numerical mark could be given to repre-

sent the heredity, the condition of heart, lungs, digestive organs, kidneys, nervous system, skin, visual organs, hearing, etc. If these were all marked on a scale of ten, which should represent perfect condition, lower numbers representing comparative deviations from this standard, a comprehensive view would be given of the mechanical conditions which tend to make a durable as well as satisfactory machine, for from one point of view man may be truly considered as a machine. These points suggested above might well be divided into two classes and marked "essentials" and "desirables." Under essentials might he placed the condition of the heart, lungs, kidneys, and nervous system. The other items might be classed as desirables but where slight deviations from perfect condition could be tolerated. A report of this kind would be of high value to an employer who might be seeking a permanent helper in any line of work.

CHAPTER III.

WHAT TO MEASURE AND HOW TO MEASURE.

In making a physical examination and measurement it is well to have the subject entirely nude, and consequently the temperature of the room must be kept as high as 75°. During the measurement the examiner should be alert in noticing any peculiarity, or deformity, or disease, or external indication of disease. The subject may then dress the lower extremities and the minute examination of the chest be continued.

When the examination is made for an institution, and is to include the measurement of many men, the services of a clerk will save at least half of the time and leave the examiner free from merely clerical work, and enable him to give all his attention to the examination in hand. With such assistance the fifty measurements can easily be made, after a little experience, in five or six minutes, and from fifteen to twenty minutes should be devoted to each individual; the latter amount if advice in regard to methods and forms of exercise, and instruction concerning diet, bathing, sleep, etc., is to be given at the time of the measurement. To economize time the specially weak or undeveloped parts should be pointed out to the subject himself, and the simplest exercises for developing those parts be recommended and illustrated if possible at a subsequent meeting.

A greater advantage will come from exercise if the object of the exercise is known than if a routine is simply followed without interest. A muscle will undoubtedly grow faster if watched and made the object of thought

during its activity, and if attention is turned to it during its period of rest. The reason of this is found in the inter-relation of the trophic and voluntary nerves.

The hygienic instruction can be given by lecture to whole classes, and a case needing special care and supervision can be asked to come to your office at some other hour when you will have time to go over the case thoroughly and examine into all the details of his habits, a knowledge of which will alone enable you to give the best advice.

If you are examining many cases in succession you will need to possess a quick memory of faces and facts or some notes will have to be taken at the time of examination that will recall the existing conditions in each case. It is well to train the memory in this matter, but take careful notes to fall back upon. A client will feel that you remember him and have given his case thought if you can show him that you know just what his condition was when you saw him last.

The number of items measured is not of so much importance as the thoroughness of the work done and the care and judgment displayed in discovering weak parts that can be strengthened, and recommending the proper remedies. But I would advise a strict adherence to the advanced standard of measurements recommended by the American Association for the Advancement of Physical Education and for three reasons: 1st, to take this complete list would require only about two minutes longer time than for the method of twenty items. 2d, the completeness of the record will be a satisfaction to all parties. 3d, uniformity of methods is of great importance in giving scientific value to work of this kind.

Then, if a person has a special desire to ride some hobby of his own and take such measurements as the horizontal length, the occipito-mental diameter of the head

and the length of the os calcis, all of which points are of some importance and have a bearing on anthropology and practical anthropometry, he is at liberty to do so.

The following technique of measuring is suggested as one that has been found to be the most economical in time and energy, and most likely to give correct interpretation of the physical proportions.

FIG. 21.

First secure the height record as follows: Place the subject in an easy erect standing position, with heels together; then step behind him and place the foot of the pole (Fig. 21) near the heels in the median plane and bring it to a perpendicular position, holding the parts firmly together with the left hand. With the right hand bring the movable hand of the caliper down upon the top of the head. Remove the pole and read the number indicated, as you wish to have it recorded by the clerk. There will be a tendency on the part of the subject to put himself in an unnatural position, and while it is essential for the person to hold himself perfectly erect it is desirable for him not to stretch himself into unusual positions. If a person does stretch himself unduly it is well for the examiner to move him one or two steps before taking his height. This puts him off his guard and enables the examiner to secure his normal height record, or the sub-

ject may be moved to one side with the same result. The method of taking heights by placing persons against the wall is faulty, as is also the stretching a person against a fixed pole, for the reason that it gives an abnormal poise. The ordinary standing height of persons with deep lumbar curve will increase by 20 to 30 mm. by having him stretch against a fixed support. The time of day when the measurements are taken also modifies the reading to some extent, the total height being greater in the morning by some 10 to 18 mm. This is due to the elasticity of the intervertebral cartilages and improved tone of the muscles that carry the body erect. A series of careful experiments, extending over a year, have been made by Mr. F. H. Curtiss, of Purdue University, on three young men to discover the loss of weight, and gain in height, during sleep. The ages of the young men were approximately 17, 19 and 20 years at the beginning of the observations. His results are as follows:

	Age	Weight (Kg.)	Loss (Kg.)	Height (Mm.)	Gain (Mm.)
E.	17	56.	.32	1698	16.3
J.	19	55.5	.33	1723	18.
F.	20	62.7	.39	1680	18.8

Next step in front of the person, placing the foot of the pole in the median line and slightly in front of the line connecting the tips of the toes. Bring the pole to a perpendicular position so that the movable arm will rest in the sternal notch and read the record. If the height of navel is seen to be more than one meter push the sliding arm up above the head and place the pole near enough to the body so that it will touch the abdominal wall when perpendicular, then read (Fig. 22). If the height be less than one meter use only the upper part of the pole placing the end of it on the floor and measure as before.

The height of the pubic arch is read from the pole while in this same position. In these two measures it is not necessary to use the sliding arm of the pole although this may be done by reversing the pole and then reading to the upper edge of the slide, instead of the lower, in order to compensate for the thickness of the fixed arm that will lie between the floor and the beginning of the graduation.

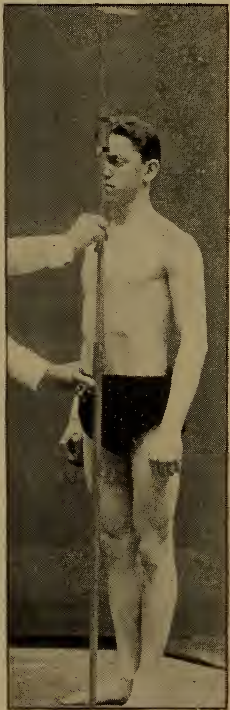


FIG. 22.

All records to this point are to be taken without having the subject move from the original position.

Next have the person sit on a stool provided for this purpose, which should vary in height, according to the general height of the group to be measured, the essential point being to have the thigh horizontal when the person is sitting. For fairly mature subjects this will be about 35 cm., and less for children. Standing behind the person place the lower end of the upper half of the pole upon the top of the stool and bring the slide down upon the top of the head (Fig. 23). Care should be taken to see that the subject is sitting perfectly erect and that the poise of the head is correct, as undue elevation or depression of the chin seriously modifies the record.

Take the height of the knee by stepping to either side and placing one hand upon the top of the knee so that the thumb shall press firmly into a notch found at the top of the fibula, and holding the rod in the other hand perpendicularly, bring the sliding arm up under the tip

Fig. 23.

Fig. 24.

of the thumb and read (Fig. 24). There seems to be no reason for not making this a bone measurement, as it is a length of bony structure that is sought. The most convenient land-mark for measuring seems to be the top of the head of the fibula, this being on the outside of the leg, and on a level with the articular surface of the joint and with the upper edge of the biceps tendon. It is, therefore, easily found in all cases.

The top of the patella has been used as a land-mark by some examiners and also a measurement to the top of the knee. It is obvious that neither of these records give the true length of the leg for comparison with the length of the thigh.

It is convenient now to take the length of the feet, and the pole is applied on the inner side of the foot as it rests on the floor so that its fixed arm rests against the greater prominence of the os calcis, the pole touching the inner surface of both the heel and the ball

FIG. 25.

of the foot (Fig 25). This saves handling the foot and insures uniform accuracy.

The subject now stands and the length of the arm from shoulder to elbow is secured by placing the forearm against the chest in a horizontal position (Fig. 26). The pole is applied against the front of the arm with the fixed arm of the caliper resting on the acromion process; the sliding arm is moved up against the olecranon process.

The length of finger tip is next secured by placing the fixed arm of the caliper against the olecranon tip and letting the rod lie along the back of the forearm. Then bring the slide against the tip of the middle finger. Care must be taken not to apply the rod in such a way that the fixed arm of the caliper rests against the triceps muscle, but essentially at right angles to the humerus. There appears to be no adequate reason for taking the length of both right and left arm.

FIG. 26.

The stretch of arms may next be taken by grasping the *upper end* of the lower half of the pole, and by applying the other end of it to the wall about the height of the shoulder of the subject, and directing him at the same

time to put the tip of his finger against the wall at the same place. While he is doing this bring the second part of the rod to position so that when you ask him to extend the other arm you have everything in position, so that you may readily move the slide against the tip of his middle finger while he is in a position of complete extension.

Now lay aside the lower half of the rod and take breadth measurements, beginning with breadth of head.

This and the next three records should be taken standing behind the person. In taking all breadths care should be taken to hold the rod so that the sliding arm may be moved by the right hand. Press the caliper firmly at a point high enough to insure including the broadest part of the skull then lower until it touches the tops of the ears. The widest part will have been included.

Fig. 27.

Great care must be exercised in securing the breadth of neck as the tissue is extremely susceptible to change under pressure. Measurements should be taken from behind with the left hand resting on the left shoulder of the subject in such a way that the thumb and forefinger can bring the fixed arm of the caliper to touch the left side of the neck (Fig. 27). The thumb of the right hand can then move the sliding arm of the caliper up to touch the right side of the neck and the correct breadth be thus secured.

I see no reason why the breadth of shoulders should not be taken at the level of the acromions and have always so taken it. This accounts for the difference in

records shown on the percentile charts of Amherst and Yale students. The subject should stand in easy position without throwing the shoulders back (Fig. 28).

The technique should obviously be the same for taking breadth of waist as for securing the breadth of the neck except that the left hand should rest upon the hip instead of the shoulder. The record should be taken at the narrowest part of the trunk or over the last rib.

After taking breadth of waist pass in front of the subject and measure the breadth of chest by placing the tips of the caliper in the axillary spaces at the level of the nipples, taking care not to place them so far back as to include any part of the latissimus muscle. The breadth of nipples should next be taken from center to center if measured at all. I perceive no adequate reason for making this record. The breadth of hips should next be measured by pressing the caliper arms firmly against the trochanters, as this should be a bone measurement. It may be well to note that the height of this diameter is the height of pubis.

Fig. 28.

In recording the measurements of women it is advisable to measure also the breadth of the hips at the pelvic crests. This can be done without including muscular tissue by applying the tips of the caliper arms to the outside of the anterior superior spinous processes of the ilii.

The measuring pole may now be laid aside and the caliper for depths used. In taking depths care must

be exercised to secure the normal position of the subject, as slight muscular movements change the depth greatly. The depth of chest is taken by applying one foot of the caliper to the spinous process, and the other to the sternum on a line between the nipples in such a way that the plane of the caliper will lie at right angles to the axis of the spine (Fig 29). The caliper must be so constructed that a spring shall hold the caliper arms against the chest with a constant tension, and a pointer affixed to one arm moving along the graduated arc will indicate the antero-posterior movements of the sternum during respiration and the maximum reading indicate the depth of chest at ordinary inspiration. The depth of the abdomen is next secured with the caliper in the same relative position to the spine, and the anterior arm resting slightly above the navel. This record is valuable only in a general way.

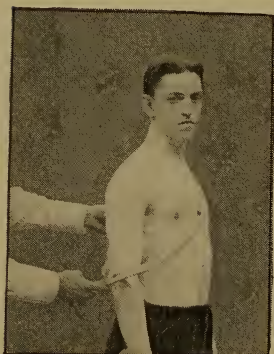


FIG. 29.

The author believes that in all cases where there is obvious asymmetry of the chest, or where there is found pulmonary disease or bone deformity, it is well to take other depth measurements as well as those prescribed by the American Association. The depth of right and left sides may well receive consideration, and their record may be taken at various heights and at indifferent phases of respiration for private records.

The girth measurements should next be taken. It is convenient to begin with girth of head, which should be taken around the largest part and cver frontal and occipital prominences. The tape may be conveniently applied by holding it between the thumb and forefin-

ger of each hand, with the hands at such a distance from each other that they shall represent about the distance to be measured (Fig. 30). The tape thus extended should be lifted over the person's head with the examiner standing at the right of the subject; the hands to be raised or lowered as may be necessary to bring the line of tape into conjunction with the greatest diameter, which may be readily appreciated from this position. After reading the tape in position it should be lowered to the neck and the record secured by measuring around the smallest part just below the larynx. It will be noticed in carefully observing the contour of the neck that there is usually a smallest part, the neck being formed essentially by two truncated cones applied to each other.

Fig. 30.

The tape is now removed from the neck and applied to the chest under the arms in such a way as to have the unit end lie upon the right half of the chest in front. The tape should embrace the lower ends of the scapulæ and lie 2 cm. above the nipples. It is convenient to record first the normal chest. (It need hardly be said that no girth measurement should be taken with the finger under the tape, but the author has seen this done by people of some little experience, especially in taking chest measurements.) Then without moving the tape have the subject inhale and expand the chest to its greatest capacity, the tape meanwhile to be removed from the

front wall by raising the ends of the tape so as to allow free play during expansion. After the reading is made have the subject exhale, flattening the chest as completely as possible. Apply such tension to the tape as shall keep it against the skin, but care must be taken that no greater tension is applied to the tape during the time of reading the record for contracted chest than for expanded chest, as will be the tendency. The girth of chest should then be taken below the pectoral muscle about 8 cm. below the nipple in both forced inspiration and expiration. This is usually called the girth at the ninth rib, the tape crossing the ninth rib in the axillary space.

The girth of waist should be measured around the smallest part of the trunk.

Care must be taken in securing this record that the subject does not contract the abdominal muscles and thereby diminish the normal size of the waist. If the subject does this I would advise the examiner to pass the tape line down and secure the girth of hips, then secure girth of waist, which will then be found usually in normal form.

In measuring girth of hips the tape should pass horizontally over the greatest protrusion of the gluteal muscles, the subject standing with heels together as in heights and breadths. After the tape has been put around the trunk for the first chest measurement it should not be removed until the girth of hips is read.

It is convenient now to begin the measurement of the limbs, and the subject should stand with the feet about 15 cm. apart with the weight borne equally upon them.

Beginning with the right biceps place the tape around the largest part, in a plane at right angles to the axis of the humerus, while the muscle is strongly flexed. The

arm is then straightened and the tape placed midway between the ends of the humerus for girth of arm (Fig. 31).

The position of the greatest enlargement during the contraction varies greatly in different people, being dependent on the relative lengths of the tendonous portions. It seems desirable that we should have a record for both biceps and arm, as a relative size of these two records gives a strong indication of the muscular condition of the subject, for if the size be largely made up of fatty tissue, the difference between the two records will be comparatively small.

FIG. 31.

The girth of elbow is supposed to indicate to some extent the bony development of the subject, if measured around the condyles. However, this record is always found to be large if the girth of the forearm be large, since the measurement must of necessity include heads of both flexors and extensors of the forearm, and these are the muscles that are measured over their largest parts in the forearm.

I prefer to have this girth indicate the extent to which the tissues of the arm extend to and coalesce with the tissue of the forearm. Consequently I measure above the internal condyle around the smallest part of the arm. The difference in the two methods is shown on the percentile tables from Amherst and Yale students (see Figs. 43 and 48).

The tape is next lowered to the largest part of the forearm, while the hand is tightly closed, and the girth

recorded. It is then lowered to the smallest part of the wrist, *i. e.*, below the styloid process, while the thumb is kept well in toward the palm.

The thigh is next measured close to the gluteal curve and the tape then lowered to the knee over the center of the patella. The girth of calf is taken around the largest part; the ankle around the smallest part. The tape is then removed and placed around the instep over the tarso-metatarsal joint. The left side is then measured in the same order. The examiner stands at the side of the subject while securing these limb measurements, rather than in front (see Fig. 24).

Below is given in full the report of the committee on statistics appointed by the American Association in 1885:

Report of the Committee on Statistics, appointed by the American Association in 1885, giving the detailed method of securing measurements, tests, and the condition of the human body.

ANTHROPOMETRIC MEASUREMENTS.

NUMBER.—In order to secure privacy the individual should be entered in the record book by number. As a means of identification the number can be entered in an alphabetical index book opposite the corresponding name, as:

Smith, John H., 526.

For further convenience it is advisable to enter the name in a numerical index book opposite the corresponding number, as:

526, John H. Smith.

DATE.—Record the year, month, day and hour, as: Jan.,'86, 12, 9 A. M. Where perfect accuracy is desired, note should be made of the time that has elapsed since eating, the occupation of previous hours, and of the temperature of the room.

Age.—Record years and months, as: 21, 9, *i. e.*, twenty-one years and nine months.

Weight.—The weight of the body should be taken without clothes. Where this is impracticable the weight of the clothes should be deducted.

Height.—The height should be taken without shoes and with the head uncovered. The head and figure should be held easily erect, and the heels together. This position is best secured by bringing the heels, the buttocks, the spine between the shoulders and the back of the head, in contact with the measuring rod.

Height of Knee.—The subject should place one foot on a box or chair of such a height that the knee is bent at a right angle. A box about twelve inches high is suitable for adults. Press a ruler upwards with a force of about one pound against the ham string tendons close to the calf of the leg. See that the ruler is held in a position at right angles to the vertical rod, and measure the height of the top of the ruler from the box.

Height Sitting.—Let the subject sit on a hard, flat surface about twelve inches high, such as afforded by a box or chair, with the head and figure easily erect so that the measuring rod will touch the body at the buttocks between the shoulders, and at the back of the head. Measure the distance from the box to the vertex.

Height of Pubes.—With the subject standing easily erect on the box or floor measure up to the lower edge of the pubic bone.

Height of Crotch.—With the subject standing easily erect on the box or floor facing the vertical rod, press a ruler firmly against the perineum (crotch) and measure the height of the top of the ruler.

Height of Navel.—With the figure and head of the subject erect, measure the height of the center of the cicatrix.

Height of Sternum.—With the figure and head of the subject erect, measure the height of the interclavicular notch.

All girths should be made on the skin itself at right angles to the axis of the body or limb at the point of measurement. No oblique measurements are taken.

Girth of Head.—This measurement should be taken around the head with the tape at the upper edge of the eye brows, over the supra orbital and occipital prominences.

Girth of Neck.—With the head of the subject erect, pass the tape around the neck half way between the head and body, or just below the "Adam's Apple."

Girth of Chest.—Pass the tape around the chest so that it shall embrace the scapulæ and cover the nipple. The arms of the subject should be held in a horizontal position while the tape is being adjusted and then allowed to hang naturally at the sides. Take the girth here before and after inflation.

Where it is desirable to test the elasticity or extreme mobility of the walls of the chest, a third measurement may be taken after the air has been forced out and the chest contracted to its greatest extent. To test the respiratory power, independent of muscular development, pass the tape around the body below the pectoral line and the inferior angles of the scapulæ, so that the upper edge shall be two inches below the nipples. Take the girth here before and after inflation.

Girth of Waist.—The waist should be measured at the smallest part after a natural expiration.

Girth of Hips.—The subject should stand erect with feet together. Pass the tape around the hips above the pubes over the trochanters and the glutei muscles.

Girth of Thighs.—With the feet of the subject about six inches apart, the muscles set just enough to sustain

the equilibrium of the body and the weight distributed equally to each leg, in gluteal fold measure around the thigh just below the nates.

Girth of Knee.—With the knee of the subject straight and the weight of the body equally supported on both legs, measure over the center of the patella.

Girth of Calf.—With the heels down and the weight of the body supported equally on both feet, the tape should be placed around the largest part of the calf.

Girth of Instep.—Measure around the instep at right angles with the top of the foot, passing a point at the bottom of the foot midway between the end of the great toe and back of the heel.

Girth of Upper Arm.—With the arm of subject bent hard at elbow, firmly contracting the biceps and held away from the body in a horizontal position, pass the tape around the greatest prominence. If desirable to find the girth of the upper arm when the biceps is not contracted, the arm should be held in a horizontal position and measured around the most prominent part.

Girth of Elbow.—Taken around the internal condyle of the humerus while the arm of the subject is straight, with the muscles of the forearm relaxed.

Girth of Forearm.—Taken around the largest part. The fist should be firmly clinched and the palm of the hand turned upward.

Girth of Wrist.—With the hands of the subject open and the muscles of the forearm relaxed, measure between the styloid process and the hand.

Breadth of Head.—The breadth of head should be taken at the broadest part. In taking the breadth measurements, stand behind the subject.

Breadth of Neck.—Taken at narrowest part with the head of the subject erect and the muscles of the neck relaxed.

Breadth of Shoulders.—With the subject standing in a natural position, elbows at the sides, shoulders neither dropped forward nor braced backward, measure the broadest part two inches below the acromion processes.

Breadth of Waist.—Taken at the narrowest part.

Breadth of Hips.—Measure the widest part over the trochanters, while the subject stands with feet together, the weight resting equally on both legs.

Breadth of Nipples.—Taken from center to center with the chest in a natural position.

Depth of Chest.—Taken after a natural inspiration. Place one foot of the calipers on the sternum midway between the nipples, and the other foot on the spine at such a point that the line of measurement is at right angles with the axis of the spinal column. When it is desirable to ascertain the extent of the antero-posterior movement of the chest, measurements may be taken from the same points after the fullest inspiration and after the fullest expiration.

Depth of Abdomen.—Place one foot of the calipers immediately above the navel, the other on the spine at such a point that the line of measurement is at right angles to the axis of the spinal column.

Length of Shoulder to Elbow.—With the arm of the subject bent sharply at the elbow and held at the side, measure from the top of the acromion process to the olecranon. Care should be taken that the measuring rod is parallel with the humerus and not with the external surface of the arm.

Length from Elbow to Finger Tip.—With the arm of the subject bent sharply at the elbow and the rod resting on back of arm and hand, measure from the olecranon process to the tip of the middle finger.

Length of Foot.—Take the extreme length of foot from the end of the first or second toe to the back of the

heel, about one inch from the surface upon which the foot rests.

Stretch of Arms.—With the arms of subject stretched out horizontally so that both hands and shoulders are in a line, with one middle finger and the zero end of the measuring rod pressed against the wall, note the point to which the other middle finger tip reaches.

Horizontal Length.—With the heels of the subject pressed hard against a perpendicular wall, with arms at the sides and body resting naturally on a horizontal plane, measure the distance of the apex of the head from the wall.

Capacity of Lungs.—The subject after loosening the clothing about the chest and taking a full inspiration, filling the lungs to their utmost capacity, should blow slowly into the spirometer. Two or three trials may be allowed.

Expiratory Strength.—As before, the subject after loosening the clothing about the chest and filling the lungs completely, should blow with one blast into the manometer. Care should be taken that no air is allowed to escape at the sides of the mouth, and that in expelling the air all the muscles of expiration are brought into play.

Strength of Back.—The subject, standing upon the iron foot-rest with the dynamometer so arranged that when grasping the handles with both hands his body will be inclined forward at an angle of 60°, should take a full breath and, without bending the knees, give one hard lift, mostly with the back.

Strength of Legs.—The subject while standing on the foot-rest with body and head erect, and chest thrown forward, should sink down, by bending the knees, until the handle grasped rests against the thighs, then taking a full breath he should lift hard, principally with the legs, using the hands to hold the handle in place.

Strength of Chest.—The subject with his elbows extended at the sides until the forearms are on the same horizontal plane and holding the dynamometer so that the dial will face outward and the indicator point upward, should take a full breath and push vigorously against the handles, allowing the back of the instrument to press on the chest.

Strength of Upper Arms, Triceps.—The subject, while holding the position of rest upon the parallel bars, supporting his weight with arms straight, should let the body down until the chin is level with the bars, and then push it up again until the arms are fully extended. Note the number of times that he can lift himself in this manner.

Strength of Upper Arms, Biceps.—The subject should grasp a horizontal bar or pair of rings and hang with the feet clear from the floor while the arms are extended.

Note the number of times that he can haul his body up until his chin touches the bar or ring.

Strength of Forearms.—The subject, while holding the dynamometer so that the dial is turned inward, should squeeze the spring as hard as possible, first with the right hand then with the left. The strength of the muscles between the shoulders may be tested with the same instrument. The subject, while holding the dynamometer on a level with the chest, should grasp it with handles and pull with both arms from the center outward.

Pilosity.—Note the amount of hair on the body and limbs, excluding the head, face and pubes.

Color of Hair.—*Light* (Very Fair, Fair, Light Brown, Brown), *Dark* (Dark Brown, Black Brown, Black). *Red* (Red Brown, Red, Golden).

Color of Eyes.—*Light* (Dark Blue, Blue, Light Blue).

Dark (Light Brown, Brown, Dark Brown, Black). *Mixed* (Gray, Green).

D. A. SARGENT,
EDW. HITCHCOCK,
WM. G. ANDERSON, } *Committee.*

The following criticisms of this Report, that now stands as the official list of the Association, are presented:

The height of knee should be a bone measurement, and the most convenient point is to top of the fibula, as the subject is sitting, and this record can be taken immediately before or after "height sitting." The present method is very inaccurate and unscientific, because the length will vary from two to three cm., according to the tension of the hamstring muscles, which are not always under the direct control of the will with the leg in the position indicated and cannot be relaxed in every case without great care. The head of the fibula can be easily found in nearly every case, and in those where it cannot be located readily the hamstring tendon can be found and it runs directly to the point sought. The record should be taken to its upper edge. The tibia can be found, and the head of the fibula is about 10 mm. shorter. The "height of crotch" need not be taken, for obvious reasons, when we have "height of pubes."

Another height-measurement advised by the Y. M. C. A. committee is the length of trunk, which is measured from the buttocks to the point of the seventh spinous process, or vertebra prominens, with the subject in the same position as for taking the height sitting. It is not always easy to decide with certainty which is the seventh spinous process; but it is usually the most prominent one, and of several that seem of equal prominence, it is usually the lowest.

The length of trunk, depth of chest and breadth of chest are three factors, that, multiplied together, may roughly be considered to represent the "vital capacity" of a person. We can get the length of trunk in another way—by subtracting the height of sternum from total height, which will give the length of head and neck; and, by subtracting this remainder from the height sitting we shall have the length of trunk.

I can discover no adequate reason for taking the horizontal length. It consumes considerable time, is a difficult measurement to take correctly, and exceedingly awkward for the subject; its average relation to the total height is a matter of anatomical record, and, in the special case it can easily be estimated by any examiner, of even limited experience, by the amount of lordosis and flexibility of the spine. Each person should take a few measurements of subjects with hollow backs, in order to get an idea of the variation in these cases; but further than this there is no utility in the recording of this item.

The breadth of shoulders should be a bone measurement as nearly as possible; for I conceive the object of it to be the determination of the extent of the bone tissue to which the more important muscles of the upper extremities and thorax are attached. If we measure below the acromion, as directed, we give a person credit for broad shoulders simply because he has a thick deltoid muscle and the muscles of the chest and arm add to the record, in such cases, by making the arm hang at an angle instead of perpendicularly, as expected.

The expiratory strength, as ordinarily taken, is misleading and untrustworthy. The intention is to gain some knowledge of the condition of the accessory muscles of expiration; for, in ordinary expiration there is little or no activity of muscles but rather a letting go or

suspension of muscular effort. (See Foster. Phys. ed. 1883, p. 315.) Now, when the subject is asked to blow as hard as he can into the apparatus, and keep the throat open, as in respiration, he will involuntarily close the pharynx with the back of the tongue and palate, and then bring the muscles of the cheeks and lips into active contraction, and, with a few efforts, acquire such skill as to rival the cornet player in the record secured.

For those who are making a special study of athletes a measurement suggested by Dr. Savage of New York is worthy of notice, namely, the length of the os calcis, this being the lever arm of the muscles that extend the foot; its relation to the metatarsal and phalangeal portion is doubtless of importance in determining the ability for such exercises as running, walking, jumping, etc.

Some points in minute anthropometry have been suggested by various specialists, but obviously such work should be left to those who wish to study some particular phase of the subject. The height of ear, girth of ankles and hands, depth of pelvis, neck and head, length of hands, fingers, ears, etc., have all been recorded by some observers.

Dr. Mosher thinks that depth of chest should be a double measurement, showing thickness of right and left chest, and the suggestion is a good one, because, in many cases the sternum is depressed and the record, if made strictly by rule, would be smaller than the subject deserves, and this method would show any asymmetry of the chest.

The French police regulations require a minute measurement of the ear and middle finger for identification of criminals if they are arrested a second time. These measures help in classifying the photographs that are taken so that they can be readily found among thousands.

Some form of anthropometrical tests can no doubt be made more serviceable in establishing identity in a "rogues' gallery" than photography. The physiological picture of a man as shown on a graphic chart is sure to retain some characteristic feature, whatever may be his condition. The imprint of the papillary ridges of the thumbs has been shown by Galton to be an efficient means of identification.

Photography may be wisely used as an adjunct of anthropometry. Since Prof. Muybridge made his wonderful pictures of animal locomotion by instantaneous process the value of a photograph to show physical deficiencies as well as excellence has been established. It makes a record in an artistic way that is made by tape and calipers in a mathematical or scientific way. Already at some of the better equipped gymnasiums photography is made to assist in preserving the record of a man's physical condition.

The tests for accuracy and strength may be made by the record in a series of athletic exercises and show something of the nerve training that the subject has had—in other words, the self-controlled power. In a person we may test the strength of fifty groups of muscles acting separately so far as possible and, while our record may be high, we may still have a very inadequate estimate of the coördinated power—the real strength of the individual, which may be small. Probably the best exhibit of a man's power is seen in such games as foot-ball, where the strength of every muscle is tested both as to its own quality and its adjustment to other muscular groups and to mental stimuli.

Another refinement of anthropometry is taking the specific gravity of a man. This may not be a feasible addition to practical anthropometry but for minute study may afford an interesting field of investigation. The

record can be taken by immersing the subject to the face or any suitable point in a reservoir of water that is situated on a scale for weighing. From the weights of the reservoir full of water, the displaced water and the immersed subject in the reservoir the specific gravity has been calculated. The fact has been often noted that men of small girths often show a weight far above what would be fairly estimated, but as yet there has been no scientific study of this class of cases to discover the relation of high specific gravity to health, strength, endurance or longevity. The specific gravity of any body is represented by the quotient obtained by dividing the weight of the body in air by the loss of weight when weighed in water.

The discovery of the superficial area of a person is of some value and may be found by the following formula: Surface, in square centimeters, $= 11 \times \sqrt[3]{\text{Weight}^2}$.

CHAPTER IV.

PERSONAL HISTORY AND EXAMINATION OF THE SPECIAL SENSES.

In examining young people the condition of the organs of special sense becomes a legitimate and important field of inquiry and record. Civilized man is as much the product of nerve reactions as he is the result of material influences that we ordinarily call hygiene—food, air, temperature, etc. The intellectual working of the brain is, in fact, more strongly influenced by defective sense impressions than it is by defective nutrition. The tinnitus of a diseased ear has driven many a person insane, and the nerve strain of an imperfect eye has produced the most serious functional diseases of the nervous system.*

The eyes should be examined by a specialist in ophthalmology if there is the slightest indication of nerve irritation, and the superficial examination, such as is indicated here, shows the slightest error of refraction or muscular insufficiency.

The record of color-blindness should be kept, not as a disease, but as a peculiarity that would render the subject unfit for some occupations. In many cases of supposed color-blindness the sense is probably simply uneducated. Cases of color-blindness among women are very rare (1 in 25,000) and are not frequent among men.

---

*See the New York *Medical Journal* for January 7 and 14, 1888, and the same journal February 27 and March 13, 1886, containing articles by A. L. Ranney, M. D., on The Treatment of Functional Nervous Diseases by the Relief of Eye-Strain, etc. Also the Belgian Prize Essay, by Dr. Stevens, of New York, and the Report of the Stevens Commission, published in *The Neurological Journal*, 1889.

Among school children and adults who are engaged in sedentary occupations requiring the almost constant use of the eye it becomes absolutely necessary that the visual organ be essentially perfect if the brain is to work with its maximum of power for a long period. That the examination of the eye is important is proved by the number of cases of error of refraction to be found in any group and the very complete remedy that is found in properly adjusted lenses.

Dr. Seelye has found that only about twenty-seven per cent of the students have normal vision. The following table shows the variety and prevalence of errors by percentages:

	Emmetropia.	Hyperopia.	Myopia.	Astigmatism.
Amherst - - -	27	44	23	22
Yale - - - -	42	23	19	35
N. Y. University - -	57	14	29	

The difference in these results is largely due to the standard of working. In the figures from Amherst the greatest accuracy exists, as all the tests were made by a trained specialist in ophthalmology.

A few brief definitions of terms used may be of assistance in understanding the table. By Emmetropia is meant normal or *perfect vision.* All rays of light coming from a distant object focus or meet at one point *exactly upon the retina* and form a *clear* image there.

Myopia or "*near-sightedness*" is due to the eye being so long from before backwards, that rays of light which enter the eye parallel or from a distance come to a focus a little *in front* of the retina and hence an *indistinct* image is formed *on* the retina.

In Hypermetropia or "*far-sightedness*" the eye is too short from before backwards, and hence parallel rays entering the eye focus *behind* the retina, and thus the image made *on* the retina is a *blurred* one.

In Astigmatism the anterior part of the eye is irregular in curvature, and therefore rays of light entering in the different diameters focus at irregular distances on, in front of, or behind the retina, so that the image of the object seen is distorted. That is all rays do not focus or meet *at the same point.*

The following directions are given for testing the refractive power of the eye and its color sense and also for determining the auditory power:

Procure of any optician two pairs of spectacles, one with convex glasses, No. +.75 Dioptric (equal to No. + 48 in the old or English system), and the other with concave glasses, No. —.75 Dioptric. Also obtain a copy of Monoyer's test letters (a card of Dr. Dennett's modification of Monoyer's test type may be procured of any optician), to be hung up at six meters distance, and a copy of Green's astigmatic lines, in the form of a clock face, to be hung up at the same distance.

Test:—Seat the subject at a distance of six meters from the test cards, which should be hung in a good light. Examine each eye separately, keeping the other covered by a card held in front of, but not touching it. Never press the fingers against the closed lid.

There are ten lines of letters on the test card, numbered from .1, .2, .3, etc., up to ten 10ths or 1. If now the subject can read the top line, the smallest letters on the card, with the right eye (R.E.) alone, his vision (V.) is recorded as ten 10ths or 1. (V.R.E.=1). If he sees nothing clearly above the fifth line from the bottom, but can read that correctly, then V.R.E.=.5. If he cannot read any of the lines, then V.R.E. is less than one-10th. Whatever the vision without glasses may prove to be, *always next* put on the *convex* spectacles and again cover the other eye. If now he can still with the right eye see as well or better than with no glasses at all, and can read the same line as before, he is Hypermetropic (Hy.) in that eye (*i. e.*, far sighted). For example, if without glasses it was found that V.R.E.=.5, and now after adding the convex glass his V. is improved to .8, the record would be V.R.E.=.5 + Hy.=.8. But if the vision is neither improved nor made worse by the convex glass, the record will be thus: V.R E.=.5 + Hy.=.5. If the convex glass can be used at all without decreasing the vision, no further testing with this card is needed; the subject is hypermetropic in that eye. If it is found that the vision of the right eye equals 1. without glasses, and then the addition of the convex glasses blurs the letters, the eye is Emmetropic (Em) that is, there is no error of refraction.

If, however, the vision without the glasses is less than 1., for instance only .3, and the convex glasses make even that line more indistinct, then put on the *concave* glasses If now the vision is improved so that a higher line can be read, for instance the eighth from the bottom, the eye is Myopic, or "near sighted," and the record will be V.R.E.=.3 + My.=.8 Or again, if the vision without glasses in the left eye is found to be .7 and then with the concave glasses the top line can be read, the record will stand thus: V.L.E.=.7 + My.=1. After testing each eye separately, place the record of one above the other, for example thus:

$$\begin{cases} \text{V.R.E} = 1.\ \text{Em.} \\ \text{V.L.E.} = .6 + \text{My.} = .9. \end{cases}$$

This completes the testing for simple hypermetropia, myopia and emmetropia.

After testing the eyes as above, if the vision has not yet been made perfect in either, leave on the proper correcting glass, the convex if there is hypermetropia, or the concave if there is myopia, or use no glass if there is neither; then direct the subject's attention with that eye alone, the other being covered, to the card of radiating black lines. If he see one or more of the lines running in any direction clearer or blacker than those at right angles to them, he is shown to be astigmatic. Either the perpendicular or the horizontal lines usually appear the blacker to the astigmatic person. If the previous record was V.R.E.=.7 and this defect is found, then it will be V.R E.=.7 + As. Or if before it read: V.L.E.=.3 + My.=.6, and astigmatism is found, it will read, V.L.E.=.3 + My.=.6 + As. Astigmatism may exist either alone or in combination with My. or Hy. If alone we might have a record thus: V.R E.=.6 + As.; V.L.E.=.4 + As , or if with hypermetropia thus: V.R.E.=.7 + Hy.=.7 + As.; V.L.E.=.6 + Hy.=.8 + As.

To recapitulate, in brief: if it is found that V.R.E.=1, then the R.E. is Emmetropic or Hypermetropic. If emmetropic, the convex glass will markedly impair the vision; if hypermetropic it will not. If the V.R.E.=.9 or less, then the R.E. is either hypermetropic, myopic, astigmatic or amblyopic.

1*st.* If it is Hy. the convex glass will not greatly impair the vision.

2*nd.* If it is My. the concave glass will improve V.

3*rd.* If it is As. one of the radiating lines is blackest.

4*th.* If neither of these defects exists and the V. is less than .7 then Amblyopia or partial blindness may be recorded. It may read thus: V.L.E.=.6 + Am.

Caution.—Always try the *convex* glass. *Never* try the *concave*

unless the convex glass blurs the vision. Have subject close the eyes when not being tested.

In the following cases the subject should be recommended to consult an oculist concerning the advisability of wearing glasses: If the vision without any glasses is less than .4 in either or both eyes; if he complains of weak, watery or painful eyes, headache, especially in reading, and any degree of hypermetropia or astigmatism is found to exist; if the eyes are unlike to the extent of .2.

Directions for Testing the Color Sense.

A set of test worsteds of different primary colors and shades, may be procured. To make the examination, spread all the worsteds out on a white cloth placed upon a table. First lay the *green* test skein a little to one side of the others, and then tell the subject to throw out of the pile and lay along side of the test skein all the lighter and darker shades of that color, or all the skeins containing a shade of that color in any degree. Avoid naming the color "green" to him. If he throws out only shades of green or light blues his color sense is normal (C.S.N.) and the test is completed. But if in addition he throws out light grays, or any other shade of gray, or light yellows, salmons, or pinks, he is color-blind. If he handles or fumbles over those shades a good deal and hesitates, as if in doubt about them, but yet does not throw them out, he probably has "feeble color sense" (C.S.F.). The examiner in these cases must use his judgment in making a certain amount of allowance for the stupidity of some persons in understanding what is wanted, especially in the young and uneducated.

If the subject is found to be color-blind, next lay down the purple or rose-colored test skein, in place of the green, in order to determine the nature of the defect. Now tell him to throw out all the different shades of that color. If he only throws out pinks and light reds and shades approaching these he is only partly color-blind. (P.C.B.). But if he throws out decidedly bluish purples, blues, violets, greens, or grays, he is completely color-blind. (C.C.B.). Completely red blind if he throws out the blues violets, etc., or green blind if the grays or greens.

No further testing is needed, but as a matter of curiosity and to prove the result, the red test skein may next be tried in the same way. If he matches with it browns or greens and grays he is completely color-blind. Dark brown or green if red blind, and light brown or green if green blind.

It is not important to record whether the complete color-blindness is red or green blindness. The following classes may be recorded:—Color sense normal=C.S.N.; Color sense feeble=C.S.F.; Partial color-blindness=P.C.B.; Complete color-blindness=C.C.B.

Color-blind individuals should be warned against engaging in any occupation where this defect would prove dangerous or inconvenient.

Directions for Testing the Auditory Sense.

Use an ordinary watch and a tuning fork, letter A, or C, as tests. Seat the subject with his right side toward you, and then while the room is perfectly quiet, see how far off he can hear the watch tick. Having previously learned by a few experiments what is the furthest distance at which the tick can be heard by normal ears, make that number of inches the denominator of a fraction, and the hearing distance of each person examined thereafter the numerator. Having found the normal distance (=H.D.) to be, for instance, about sixty inches, and that of the subject now examined to be, say forty inches, his record for the right ear would then be: H.D.R.E.$=\frac{40}{60}$. If it had been $\frac{60}{60}$ or 1, the ear would be normal. $\frac{80}{60}$ would show an abnormally acute sense of hearing. If the watch could only be heard while in *contact* with his ear, it would be recorded: H.D.R.E.$=\frac{c}{60}$. If not heard at all, then H.D.R.E.$=\frac{0}{60}$. Next test the left ear in the same way. Voice sounds in talking will often be easily heard by persons quite deaf to the watch tick, so that the latter is not always a reliable practical test.

Suppose we have found H.D.R.E.$=\frac{40}{60}$, H.D.L.E.$=1$, this implies some deafness in the right ear, and the tuning fork will now help us to decide whether the cause lies in some defect of the auditory nerve or internal ear, or in the external or middle ear or Eustachian tube. Strike the fork against some solid substance, and then place the end of the handle against or between the subject's front teeth. If both ears are normal he will probably seem to hear the ringing of the fork equally well in both ears. But if there is a defect in one ear he will either seem to hear it louder or more feebly in the affected ear. If, as in the case we are examining, the fork is heard best in the deaf ear, this tells us that the deafness is due to some defect in the more external parts of the organ, and it can probably be corrected by appropriate treatment. But if it is heard best in the good ear, it goes to prove that the defect in the other ear is more deeply seated and cannot probably be greatly benefited by treatment. This effect of the tuning fork is contrary to what would ordinarily be expected, and it is often a matter of surprise to a deaf person to find that he hears with his teeth apparently better on the deaf side.

We may now add to our record in this case: T.F. best R.E. If it had been heard equally well in both ears we would record: T.F.=N. (or normal). Where the defect in hearing is at all marked a specialist in ear diseases should be consulted.

Our record in a normal case might be thus: H.D.R E. = 1, H.D.L.E. = 1., T.F. = N.; or in an abnormal case it might be thus: H.D R.E. = 1., H.D L.E. = $\frac{0}{60}$, T.F. best in R E. This would imply that the subject was so deaf in the left ear as not to be able to hear the watch tick at all, and the fork held between the teeth could be heard best in the good ear, consequently his trouble is probably seated in the deeper structures of the ear, or in the nerve itself, and treatment would not be expected to help him greatly. The tuning fork need not be tried unless the watch tick shows some defect in hearing.

When tests of the hearing are made, any dullness or difference in the auditory sense of the two ears should lead to an examination with the otoscope. The channel may be partially or completely occluded with wax or the debris from a previous inflammation or an exostosis of the wall of the meatus. If the opening is normal, the tympanum, or drum, will be seen at a depth of about two centimeters as a smooth, shining, semi-transparent membrane of slightly pinkish-gray color. In cases of inflammation the drum becomes decidedly pink. Slightly below and in front of the center is a white spot as though some white body pressed the drum slightly forward at that point. This is the end of the bone, the malleus, that conveys the vibrations back to the internal ear. In most cases a gray streak can be seen extending upward and forward, which is the body of the bone. Sometimes the drum will appear bulging and convex, from the pressure of serum within, and the vibrations of the drum are prevented, with resulting deafness. Again the drum may appear cupped or concave from the stoppage of the eustachian tube and the subsequent absorption of air in the middle ear, so that the drum is pushed in by the atmospheric pressure. This is by far the more common condition and only impairment of hearing results until the case is of long standing, when complete deafness may ensue. Openings in the drum are of frequent occurrence as the result of inflammatory exudation bursting

through from the inside, or traumatic puncture that has been uncared for. A puncture may not impair the hearing to any serious extent. Suppuration of the ear in any part should be the subject of surgical treatment at once, without regard to the whims or prejudices of the person possessing an otorrhœa. The discharge is often looked upon as a necessary affliction, and relief from other woes, but in reality it is a source of debility and impairment of health to the person himself, and a nuisance to others. Cases of impaction require treatment, and the same may be said of the convex drum. The concave drum may be due to catarrh, and if so, that should be treated. All these cases are to be referred to physicians.

An organ may work correctly but slowly. The eye of one person sees at a glance what the eye of a second person would require seconds to reveal, and yet the eye of the latter may be perfect according to every test of the oculist. It is so with hearing. The time required between hearing and perceiving sounds and giving a signal is .12 to .18 of a second. Higher tones require slightly less time than deeper ones. Noises are heard quickest.

A distinguished teacher recently told me that he had called a certain boy stupid until he discovered that the boy was merely slow in his sense of hearing. Since that time he has studied boys whose perceptive faculties seemed dull and has found that a large percentage of them are deficient mainly in hearing a question that is put rapidly to them. A device that will test the speed of the action of the eye and ear correctly within moderate limits of accuracy will be of great practical importance in an educational as well as scientific aspect. Physical education must bring up to a higher plane of activity each physical function that is found to be deficient. To do this the examiner must be ever alert to discover undeveloped functions and inventive ability will be frequently required to solve the problems presented.

In this connection it may be well to speak of nasal catarrh and its influence on health. The disease may be considered as a condition of mal-nutrition of the part affected, due to irritation of the trophic nerves. It may appear as an inflammation of the upper air passages with an increased secretion of mucous fluid; or there may be atrophy of the mucous surfaces and of the harder tissues beneath; or there may be extensive ulceration, and decomposition of secretions.

The first form is due to the action of irritants on a supersensitive membrane. The condition can be produced almost instantaneously by the inhalation into the nasal openings of snuff from pulverized tobacco, acrid fumes, dust, etc., but the hyperaemia is temporary if the irritation is not repeated. Sudden changes from a warm to a cold atmosphere do not give the system time for the nice adjustment to environment that enables man to live in every climate where food can be found. The result is a continued irritation of the mucous surfaces of the air passages and a resulting inflammation with thickening of the superficial tissues until the normal nutrition of the part is lost, and disease becomes seated. This swelling may close the openings of the eustachian tubes, and impaired hearing is the result. Treatment is usually successful, and hence the importance of examining the nasal chambers if the history discloses any suspicion of defect in this locality. The other forms of catarrh are often quite as distressing without as favorable a prognosis, but relief will not be sought in vain.

The sense of smell in the atrophic and erosive forms of catarrh is often entirely lost, and in all cases is deranged. This sense may be tested by inhaling odors that are bland and unconnected with articles of food, as musk, attar of roses, etc.*

---

* Scripture — Thinking, Feeling, Doing. p. 124.

The olfactory nerve is perhaps more intimately connected with the brain tissue than any other, being apparently a prolongation of the brain through the cribriform plate to the nasal walls. As many cases of headache are due to a bad condition of the surfaces where this nerve is spread out we should examine such cases for ulcerations, tumors, malformations and displacements that may cause occlusion or pressure.

The sense of taste is closely allied with that of smell, but is not so important an indication of the condition of the organs with which it is connected. It is a sense with great capacity for education, as it was the boast of Roman epicures that they could tell by the taste of a fish whether it was caught above the Bridge or below. A taste may be acquired for the most nauseating substances. Children have been known to cry for cod-liver oil. But while the sense of taste is not important in its relation to health, the condition of the mouth may well occupy our attention in discovering those facts in a man's condition that make for health or debility. A clean tongue indicates good digestion; while a coating indicates some abnormal condition of the stomach, or liver, or pharynx. A cracked tongue means dyspepsia. The tonsils should not protrude beyond the pillars of the fauces; the general surface of the pharynx should be smooth and of light pink color; the teeth should be sound or filled; the vocal cords should be a light, pinkish yellow, and the tracheal rings below look like white bands, between which pink tissue can be faintly discerned.

The temperature should be taken with the bulb of the thermometer placed under the subject's tongue for five minutes. This should be a record of 98.4° F. without a variation of half a degree. If the temperature is below normal note carefully the general conditions and repeat

the test at some future time. About one or two per cent of cases have a subnormal temperature. The instrument should be carefully washed in an antiseptic fluid after using and it is well to have a cup of saturated solution of boracic acid into which the mouth-piece of spirometers, etc., can be placed after taking records with them.

The tests of urine for albumen and sugar should be practiced until the examiner is sure of his ability. The chemicals now prepared by leading manufacturing chemists and druggists leave little except skillful manipulation to the examiner. The record should be repeated if any abnormality is found and the subject placed under the advice of a physician.

The director of a gymnasium should *always* recommend some other physician to cases needing medical care.

CHAPTER V.

TESTS OF STRENGTH.

The importance of strength tests as a department of anthropometry demands that special attention be given to it at present. The earlier tests that were applied in anthropometrical investigations related to the size or mass of the various parts of the body, and it was supposed that high record, coupled with a good proportion, constituted a highly desirable condition and that exercise might be prescribed on this basis. Practical experience, however, soon demonstrated the absolute need of other data than those relating to bulk and proportion if exercise were to be prescribed appropriate to the capacity of the individual. The large man is not always the strong man, and with equal truth it may be said that the strong man is not always the man of high endurance. The working muscle is a machine that depends upon two factors for its efficiency. First, it must have size, or an adequate aggregation of cells, each one of which is involved in the activity of the whole, as the total strength of the muscle is made up of the sum of the strengths of the individual cells composing it. Second, it must have adequate innervation in order to set up the metabolism that sets free the stored energy. If continued exertion is to be considered, a third important factor appears, namely, sufficient circulatory activity to bring fuel to the cells and to sweep away combustion products The variety in the girths of different individuals, especially in the first half of life, may be attributed in some degree to the difference in the size of the muscles, but the modifications may be largely due to the presence of storage tissue that has no imme-

diate relation to the muscular ability. The girth of the head, on the other hand, bears no direct relation that has yet been determined to the nerve force that may be applied as a stimulus to muscular contraction. We must, therefore, in estimating the muscular ability of a person, have other data than the record of size. Since muscular activity is externally manifested in forms of strength acting against resistance it would seem plausible that a series of strength tests that should at least include the principle groups of muscles would be a safer guide in determining the amount of work that may be advantageously done, than any other data that can be secured. To secure such tests of strength has taxed the ingenuity of physical directors in times past and with some the extensor power of the legs in lifting has been considered a fair test of the person's muscular power and preparation for work. Others, more devoted to that form of exercise ordinarily classified as *heavy gymnastics*, have considered the strength of the extensors of the arm as a similar indication. Medical men have relied particularly on a test of the contractile power of the flexor muscles of the hand. With the advance of anthropometric science the inadequacy of local strength tests has been demonstrated, and gradually methods of testing with fair accuracy all the general groups of muscles have been established. The earliest forms of dynamometers that have been found fairly efficient in securing local tests are shown in the accompanying cuts (Figs. 11-12-15). The general type of these instruments has been that of the elliptic spring. The variation of its contour being accomplished by pressure or by tension, and recorded by an index that is moved forward by the moving side of the spring. These instruments have been of French design and have been applicable only to a very limited range of use. About ten years ago Dr. J. H. Kellogg, the medi-

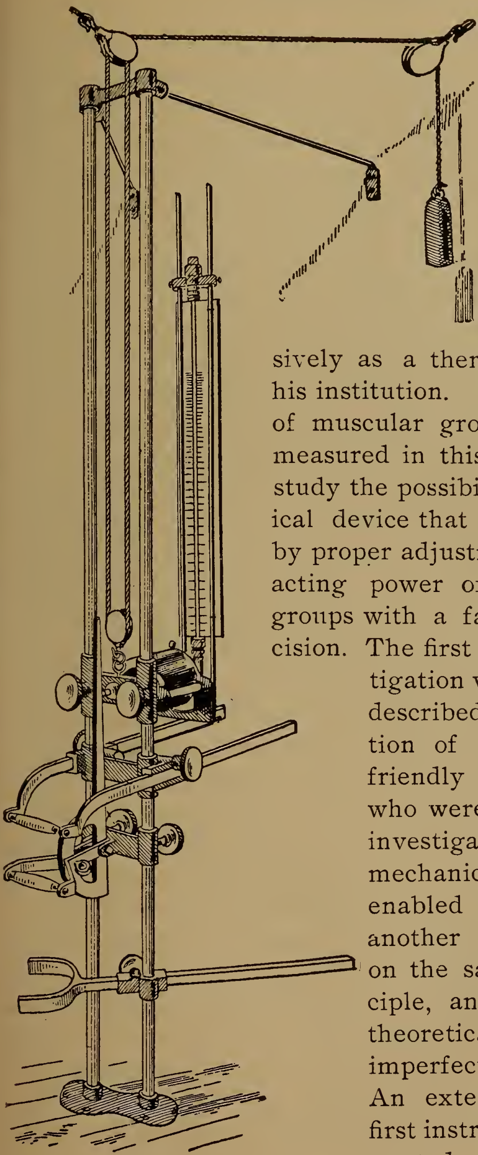


FIG. 32.

cal superintendent of an extensive sanitarium at Battle Creek, Mich., began to apply strength tests as a preliminary to the exercise which was prescribed extensively as a therapeutic means in his institution. The small number of muscular groups that could be measured in this way led him to study the possibilities of a mechanical device that should be capable by proper adjustment to record the acting power of all the skeletal groups with a fair degree of precision. The first result of his investigation was the instrument described in a previous edition of this book. The friendly criticism of those who were interested in his investigation and his own mechanical genius soon enabled him to produce another instrument, based on the same general principle, and relieved of the theoretical and mechanical imperfection of the first. An extensive use of the first instrument had demonstrated the faults that

should specially be guarded against in the later product. His instrument as now completed is shown in Fig. 32, and consists essentially of a frame made of two upright rods, which serve as a support to the testing mechanism. This mechanism balanced by a counter-weight can be readily moved up or down to any position, and there fixed by four set screws to the frame. The mechanism consists of a lever arm terminating in a handle, which is always the point of application of the force. This lever can be moved upon its fulcrum through ninety degrees so as to receive force applied in a horizontal or in a perpendicular direction. A coupling pin transfers this force to a perpendicular lever arm which acts against the resistance. This resistance is secured by the following mechanism: A glass tube of 1 mm. calibre and one meter in length runs to the bottom of an iron cistern where it is tightly held by a screw acting upon a rubber washer. The bottom of the cistern contains two ounces of mercury. A layer of water is superimposed upon the mercury and the cistern is then completely filled with light machine oil or alboline. Connected with this cistern is a horizontal cylinder into which a piston of about 60 mm. diameter fits with mechanical exactness, and the end of this piston is acted upon by the lever arm of resistance described above. The other end acts upon oil which fills the cylinder to the extent of about one-third of its capacity. When force is applied to the handle, pressure is exerted upon the end of the piston, which in turn acts upon the oil, driving it through into the cistern containing the mercury and water, and as the only opening into this cistern is by the glass tube, the mercury is driven up into this tube, until the pressure of the compressed air in the tube, plus the weight of the mercury column, balances the pressure exerted upon the handle of power. The graduation of the instrument is accomplished by

having the rods that support the glass tube carry a scale that is marked empirically into spaces. It will be seen at a glance that the mechanical conditions are perfect and constant for a constant temperature. The capacity of this instrument is sufficient to record a pressure as light as one-fourth of a kilogram and it has been repeatedly subjected to a strain of 800 kg. without injury. In connection with Dr. W. A. George, Dr. Kellogg has prepared percentile charts from the records of the strength tests of six hundred men and six hundred women that may serve us as a basis for the graphic representation of the strength of any person. Reduced copies of these charts are shown in Figs. 33-34. It should be stated that these charts are not prepared strictly according to the percentile method, but are a combination of the average and percentile methods as described on page 188 of Dr. Kellogg's "The Art of Massage." It need only be added that this method gives great authority to the fifty per cent line, as representing an essential average of a group from which monstrosities have been eliminated.

I can testify from personal observation to the facility and accuracy with which exercises may be indicated for a person when his strength record is graphically presented on one of these charts. The general theory and method of the prescription cannot be better described than in Dr. Kellogg's own words which are taken from the book above mentioned:

"The data afforded furnish exact information concerning the capacity of each of the principal muscles in the body. Knowing the capacity of each muscle, it is easy to proportion the work in such a manner as to secure symmetry of development. My plan for accomplishing this is as follows:

"Take 300,000 foot pounds, one-sixth of a full day's work, as the proper daily amount of exercise for a man

—PHYSICAL CHART—

Arranged from the results obtained in testing the strength of the individual groups of muscles in 600 MEN, by means of a Universal Mercurial Dynamometer, made and compiled under the direction of J. H. KELLOGG, M. D., Superintendent of the Sanitarium and Hospital, Battle Creek, Michigan.

Except when Otherwise Indicated, Quantities are Expressed in Pounds Avoirdupois.

PER CENT.	HEIGHT (inches).	WEIGHT.	ARMS. R. Hand Flexors.	L. Hand Flexors.	R. Hand Extensors.	L. Hand Extensors.	R. Forearm Pronators.	L. Forearm Pronators.	R. Forearm Supinators.	L. Forearm Supinators.	R. Arm Flexors.	L. Arm Flexors.	R. Arm Extensors.	L. Arm Extensors.	R. Deltoid.	L. Deltoid.	R. Pectoral.	L. Pectoral.	R. Shoulder Retractor.	L. Shoulder Retractor.
1	74.3	216	205	204	68	62	121	123	119	112	111	116	110	113	137	136	164	174	148	143
2	72.7	185	180	175	56	55	109	98	102	100	96	94	97	97	100	101	151	146	123	125
3	72.2	179	170	167	[illegible]	52	97	94	99	96	94	90	92	93	94	96	142	139	117	119
5	71.6	176	162	159	[illegible]	48	90	87	95	92	86	83	86	85	90	90	133	130	108	111
10	71.4	164	150	149	42	41	83	81	88	84	75	80	80	77	80	83	123	120	98	101
15	70.5	156	142	140	38	37	79	76	83	80	70	72	74	72	77	78	116	113	93	94
20	69.9	150	136	134	35	34	75	72	79	76	66	67	70	69	74	75	111	108	88	89
25	69.5	147	130	128	32	31	72	69	76	73	62	63	67	65	72	72	106	104	84	84
30	[illegible]	144	126	123	30	29	69	66	73	70	59	59	64	63	69	69	102	100	81	80
35	68.6	141	122	118	28	27	66	64	70	67	56	56	61	61	67	67	98	97	77	77
40	68.3	138	118	114	26	25	63	61	67	64	54	52	[illegible]	58	66	66	94	93	74	75
45	[illegible]	136	114	111	25	23	61	59	65	62	51	50	[illegible]	56	63	62	91	90	71	70
50	68.0	134	110	107	23	22	58	56	62	59	49	47	54	54	60	60	87	87	68	67
45	67.4	131	107	103	22	21	56	53	59	57	[illegible]	44	51	52	58	57	84	83	66	64
40	67.0	129	103	100	21	19	53	52	56	54	44	42	49	49	56	55	80	80	62	62
35	66.7	127	100	97	19	18	51	49	54	52	41	40	46	47	53	53	77	76	60	59
30	66.7	124	96	93	18	17	48	47	51	49	39	37	44	44	60	50	74	73	67	56
25	66.1	122	93	90	17	15	46	44	48	46	36	35	41	42	47	48	70	69	54	53
20	65.6	119	90	87	15	14	43	42	44	43	33	32	38	38	44	45	66	65	50	49
15	65.1	114	85	83	13	12	39	38	40	39	29	30	34	35	40	42	62	60	46	45
10	64.5	112	79	[illegible]	11	10	35	34	35	[illegible]	25	25	30	30	34	37	55	54	40	39
5	63.6	106	69	[illegible]	9	8	27	27	27	27	20	20	24	24	31	34	45	46	30	30
3	62.9	102	61	[illegible]	7	6	22	23	23	23	16	18	20	20	26	25	38	40	24	25
2	62.4	100	56	[illegible]	5	5	21	20	20	20	15	15	17	16	21	21	32	32	20	20
1	61.1	88	27	27	3	4	11	12	9	10	10	9	10	11	15	16	17	14	13	11

PER CENT.	LEGS. R. Foot Flexors.	L. Foot Flexors.	R. Foot Extensors.	L. Foot Extensors.	R. Leg Flexors.	L. Leg Flexors.	R. Leg Extensors.	L. Leg Extensors.	R. Thigh Flexors.	L. Thigh Flexors.	R. Thigh Extensors.	L. Thigh Extensors.	R. Thigh Abductors.	L. Thigh Abductors.	R. Thigh Adductors.	L. Thigh Adductors.
1	109	115	503	579	178	181	197	195	243	245	271	279	178	182	172	178
2	96	98	412	414	144	143	182	174	206	214	230	237	163	163	154	158
3	93	94	399	401	138	137	170	167	199	204	223	230	158	158	147	144
5	91	91	383	385	131	129	169	157	189	194	213	217	151	151	139	138
10	85	85	341	358	119	117	147	144	174	179	198	197	138	136	126	125
15	81	81	329	339	112	110	137	135	163	167	185	185	129	131	117	116
20	78	78	318	325	106	104	129	128	165	159	175	176	123	125	110	110
25	76	75	307	313	102	100	123	122	149	152	166	167	117	119	106	105
30	74	73	297	301	98	96	118	117	144	147	159	160	112	114	101	101
35	71	71	287	290	94	93	113	113	139	141	153	154	108	110	98	98
40	69	69	278	280	91	89	109	109	134	136	146	147	103	105	95	95
45	67	66	272	269	87	86	105	104	129	131	140	141	99	102	92	92
50	65	64	263	258	84	83	101	100	124	126	134	136	95	98	89	89
45	62	62	254	247	80	79	97	96	120	121	128	129	91	94	86	86
40	60	59	243	236	77	76	93	93	115	116	122	123	88	[illegible]	83	83
35	[illegible]	61	234	226	73	73	89	88	110	110	116	117	84	87	80	80
30	54	54	224	214	70	70	86	84	104	106	110	111	80	83	77	77
25	52	52	213	202	66	67	81	79	98	101	104	105	76	79	74	74
20	49	48	202	189	62	63	[illegible]	76	93	96	98	97	72	74	71	70
15	45	46	[illegible]	176	57	59	72	70	86	90	90	90	68	71	67	66
10	40	40	179	160	61	54	67	64	78	83	79	61	62	66	61	60
5	34	33	165	144	42	45	54	54	68	67	70	69	52	64	53	50
3	30	28	133	133	37	38	46	46	59	56	63	63	45	49	47	44
2	27	24	118	116	33	35	40	39	[illegible]	48	57	68	41	41	42	40
1	21	16	89	78	23	18	26	24	35	38	38	37	26	29	29	27

PER CENT.	TRUNK. Trunk Anterior.	Trunk Posterior.	Trunk R. Lateral.	Trunk L. Lateral.	Neck Anterior.	Neck Posterior.	Neck R. Lateral.	Neck L. Lateral.	RESPIRATION. Inspiration — Waist.	Inspiration — Chest.	Inspiration — Waist Expans'n (in.)	Inspiration — Chest Expans'n (in.)	Expiration — Pneumometer.	Expiration — Spirometer (cubic in.)	TOTAL STRENGTH. Arms.	Legs.	Trunk.	Chest.	Entire Body.	PER CENT.
1	283	697	250	262	69	123	104	103	319	339	6.4	5.7	246	393	2365	3805	1897	664	8731	1
2	225	575	203	206	60	103	91	90	279	300	5.0	5.1	208	356	2005	3188	1552	584	7329	2
3	213	547	194	191	56	98	87	87	268	288	4.7	4.9	196	344	1910	3062	1473	561	7006	3
5	199	516	183	181	52	92	82	82	252	274	4.4	4.7	182	329	1774	2918	1386	531	6609	5
10	180	474	169	174	47	86	76	76	227	244	4.0	4.3	158	326	1637	2669	1282	475	6063	10
15	164	438	159	163	43	82	71	71	206	223	3.7	4.0	148	311	1534	2517	1191	433	5676	15
20	153	409	152	155	40	79	68	67	187	208	3.4	3.8	140	301	1458	2399	1123	399	5379	20
25	144	384	146	149	38	76	65	64	175	196	3.2	3.6	134	293	1390	2299	1066	374	5129	25
30	137	363	140	143	36	73	62	61	165	187	3.1	3.4	128	284	1332	2212	1015	355	4914	30
35	130	343	134	137	34	71	60	58	155	177	[illegible]	3.3	122	276	1279	2093	967	335	4674	35
40	125	326	129	131	32	68	67	56	146	168	[illegible]	3.2	118	265	1227	2055	924	317	4523	40
45	119	309	123	125	30	65	65	64	138	160	[illegible]	3.0	114	259	1190	1982	880	301	4353	45
50	114	292	117	119	28	63	62	52	[illegible]	152	[illegible]	2.9	110	[illegible]	1130	1903	837	286	[illegible]	50
45	109	276	112	114	26	61	60	60	123	[illegible]	[illegible]	2.8	106	[illegible]	1082	1832	798	270	3982	45
40	104	260	[illegible]	109	[illegible]	58	48	48	116	[illegible]	2.4	2.7	100	[illegible]	1037	1757	759	256	3809	40
35	99	245	102	[illegible]	23	56	46	45	109	129	2.2	2.6	96	[illegible]	992	[illegible]	719	240	3632	35
30	94	[illegible]	96	99	21	63	[illegible]	[illegible]	103	122	2.1	[illegible]	92	[illegible]	944	1603	679	227	3453	30
25	89	[illegible]	91	94	19	51	39	40	97	116	2.0	[illegible]	86	222	[illegible]	1523	638	214	3270	25
20	86	198	86	89	18	48	36	37	90	108	1.9	[illegible]	82	215	[illegible]	1436	598	200	3071	20
15	81	182	79	83	17	[illegible]	32	34	83	101	1.8	[illegible]	[illegible]	206	772	1343	653	186	2854	15
10	[illegible]	158	70	76	14	41	27	30	73	[illegible]	1.5	[illegible]	[illegible]	195	688	[illegible]	[illegible]	166	2569	10
5	60	126	60	67	11	32	22	[illegible]	68	76	1.3	1.5	58	175	581	1044	404	135	2144	5
3	53	110	[illegible]	60	10	28	18	21	48	68	1.1	[illegible]	52	163	[illegible]	917	350	117	1558	3
2	44	100	43	56	9	25	16	18	39	62	1.	1.3	[illegible]	155	407	814	311	102	1634	2
1	32	[illegible]	34	44	5	16	9	10	27	31	.8	1	[illegible]	127	233	654	281	59	1077	1

Feb'y 9 1893

Jany 1 1893

Strength Measurements of Mr. A. ——— Taken Jany 1, 1893, Feby 9, 1893, ——189— ——189— by M.A.M. M.A.M.

Arranged from the results obtained in testing the strength of the individual groups of muscles in 600 WOMEN, by means of a Universal Mercurial Dynamometer, made and compiled under the direction of J. H. KELLOGG, M. D., Superintendent of the Sanitarium and Hospital, Battle Creek, Michigan.

Except when Otherwise Indicated, Quantities are Expressed in Pounds Avoirdupois.

PER CENT.	HEIGHT (Inches).	WEIGHT.	ARMS. R. Hand Flexors.	L. Hand Flexors.	R. Hand Extensors.	L. Hand Extensors.	R. Forearm Pronators.	L. Forearm Pronators.	R. Forearm Supinators.	L. Forearm Supinators.	R. Arm Flexors.	L. Arm Flexors.	R. Arm Extensors.	L. Arm Extensors.	R. Deltoid.	L. Deltoid.
1	68.4	202	118	107	30	30	60	59	62	62	53	52	57	57	80	75
2	67.4	177	97	89	27	25	48	49	48	46	43	42	47	47	59	59
3	66.9	170	92	84	25	24	45	46	46	44	41	40	45	40	55	56
5	66.3	161	83	82	23	22	42	41	42	40	35	38	41	40	51	52
10	65.3	[illegible]	75	74	20	16	36	38	38	35	33	29	38	[illegible]	49	46
15	64.8	[illegible]	70	69	18	16	33	[illegible]	34	31	30	27	35	[illegible]	44	42
20	64.4	133	68	65	17	15	31	32	32	29	27	25	31	30	41	39
25	64.[illegible]	129	65	63	16	14	29	29	30	27	25	24	29	28	37	36
30	63.[illegible]	126	62	59	15	[illegible]	28	27	28	26	23	23	26	25	35	34
35	63.[illegible]	123	59	57	14	12	27	26	26	24	21	21	24	24	33	33
40	63.1	120	56	54	13	11	25	24	24	23	20	20	23	22	31	30
45	62.9	118	54	52	12	11	24	23	23	21	19	19	22	21	29	28
50	62.6	115	51	49	11	10	23	22	21	20	18	18	20	19	27	26
45	62.3	112	49	47	10	9	21	20	20	19	17	17	19	18	25	25
40	62.0	110	47	45	9	8	20	19	19	17	16	16	18	17	23	23
35	61.8	108	44	43	9	7	19	17	18	16	15	14	17	16	22	21
30	61.5	105	42	40	7	6	18	16	17	16	14	13	15	15	20	20
25	61.2	103	40	38	6	6	16	15	15	14	13	12	14	14	18	18
20	60.8	100	37	36	5	5	15	13	14	13	11	11	13	13	16	16
15	60.4	97	34	33	4	5	13	12	13	11	9	9	12	11	14	15
10	59.8	93	30	29	3	4	10	9	11	10	7	7	11	10	11	13
5	58.7	88	25	22	3	3	8	6	7	6	5	5	7	7	9	9
3	58.4	85	22	19	2	2	6	4	5	5	4	4	6	5	7	7
2	58.0	81	20	13	2	2	5	3	4	4	4	3	5	5	6	6
1	56.5	77	10	12	1	1	2	2	2	2	2	2	2	2	5	4

PER CENT.	ARMS. R. Pectoral.	L. Pectoral.	R. Shoulder Retractor.	L. Shoulder Retractor.	LEGS. R. Foot Flexors.	L. Foot Flexors.	R. Foot Extensors.	L. Foot Extensors.	R. Leg Flexors.	L. Leg Flexors.	R. Leg Extensors.	L. Leg Extensors.	R. Thigh Flexors.	L. Thigh Flexors.
1	93	86	101	99	88	86	316	318	103	104	130	124	153	150
2	78	76	82	81	72	71	276	268	93	92	96	96	125	125
3	75	72	78	75	68	67	264	257	87	86	92	92	121	120
5	71	68	71	71	62	60	248	244	81	81	87	86	116	114
10	62	64	66	61	54	53	221	219	72	71	77	77	107	104
15	58	59	60	57	50	49	205	205	66	65	70	71	100	97
20	55	55	55	52	47	46	193	192	62	61	65	67	93	90
25	52	52	51	[illegible]	44	44	182	182	57	57	60	62	87	85
30	49	[illegible]	45	46	[illegible]	[illegible]	173	172	54	54	57	58	82	80
35	46	46	45	43	41	40	164	163	51	50	54	55	77	76
40	44	44	42	40	39	38	157	155	48	48	51	52	73	72
45	43	41	39	38	37	36	149	148	45	45	49	49	69	69
50	40	39	37	36	35	35	142	141	42	42	46	46	66	65
45	37	37	35	33	34	33	135	134	40	40	43	43	62	62
40	36	35	33	31	32	31	128	127	37	37	41	41	59	59
35	33	34	31	29	30	30	121	121	35	34	38	38	55	55
30	31	31	29	26	28	28	115	114	32	32	35	36	52	52
25	29	29	26	24	26	26	108	107	30	30	33	33	49	49
20	27	27	23	21	24	24	101	100	28	27	30	31	45	45
15	24	25	20	18	22	21	93	93	25	25	28	28	42	42
10	21	23	17	15	20	18	86	86	22	22	25	24	37	36
5	17	16	15	15	18	14	73	73	18	17	20	19	30	30
3	15	13	13	13	13	11	63	63	16	14	17	16	27	25
2	14	11	11	10	12	10	56	54	14	12	14	13	25	24
1	11	9	8	7	8	6	31	29	9	7	8	8	20	17

PER CENT.	LEGS. R. Thigh Extensors.	L. Thigh Extensors.	R. Thigh Abductors.	L. Thigh Abductors.	R. Thigh Adductors.	L. Thigh Adductors.	TRUNK. Trunk Anterior.	Trunk Posterior.	Trunk R. Lateral.	Trunk L. Lateral.	Neck Anterior.	Neck Posterior.	Neck R. Lateral.	Neck L. Lateral.
1	157	151	123	128	118	119	134	430	149	142	39	64	63	61
2	123	124	104	104	105	99	121	341	119	119	33	60	49	49
3	118	122	100	100	101	94	116	324	112	114	32	56	46	46
5	110	115	93	94	93	90	109	291	107	108	30	51	42	42
10	100	103	84	85	81	82	93	244	98	99	28	45	41	38
15	93	96	77	78	74	74	86	216	91	92	24	42	37	34
20	87	90	73	73	70	70	78	184	85	86	21	40	34	32
25	81	85	69	6[illegible]	66	66	72	175	79	79	19	37	31	29
30	77	80	66	65	63	63	68	162	73	73	18	35	29	27
35	72	76	63	62	60	60	63	150	69	68	17	34	27	25
40	68	72	60	59	57	56	59	140	64	64	16	32	25	24
45	65	69	57	57	53	53	55	131	60	60	15	30	23	23
50	61	65	55	54	51	51	51	123	56	56	13	29	22	21
45	58	61	52	51	48	48	48	115	53	52	12	27	20	20
40	55	58	49	49	45	45	44	108	49	49	11	26	19	18
35	52	55	47	46	42	42	41	101	45	45	10	25	18	17
30	49	52	44	44	39	40	38	93	42	42	9	22	17	16
25	46	48	41	41	37	37	34	86	38	38	8	21	15	14
20	43	45	38	38	34	34	30	78	35	34	7	19	14	13
15	39	41	35	35	31	30	27	69	31	30	6	17	13	11
10	34	36	30	30	26	27	23	58	26	26	5	15	12	9
5	27	29	25	25	22	22	19	48	21	21	2	12	7	7
3	23	25	22	22	19	19	16	40	18	18	1	11	5	5
2	21	22	20	20	17	17	15	26	16	17	1	9	4	4
1	11	13	15	15	11	12	10	22	12	12	1	5	2	2

PER CENT.	RESPIRATION. Inspiration—Waist.	Inspiration—Chest.	Inspiration—Waist Expans'n (in.)	Inspiration—Chest Expans'n (in.)	Expiration—(Pneumatometer, M. B. of Mercury.)	Expiration—Spirometer (cubic in.)	TOTAL STRENGTH. ARMS.	LEGS.	TRUNK.	CHEST.	ENTIRE BODY.	PER CENT.
1	166	181	5.6	5.5	176	240	1281	2368	1103	350	5102	1
2	129	145	4.7	4.7	136	224	1043	1973	891	277	4184	2
3	128	136	4.4	4.5	134	217	983	1889	846	267	3985	3
5	112	126	4.1	4.2	118	211	913	1774	780	240	3707	5
10	98	108	3.7	3.9	94	201	818	1590	686	208	3302	10
15	90	98	3.3	3.6	84	193	750	1470	622	180	3031	15
20	84	91	3.1	3.3	78	185	699	1379	559	176	2813	20
25	78	84	3.0	3.2	72	180	656	1296	521	163	2636	25
30	73	79	2.8	3.0	68	173	616	1229	485	153	2483	30
35	69	74	2.6	2.9	64	167	581	1164	453	144	2342	35
40	65	70	2.5	2.7	58	162	546	1105	424	136	2211	40
45	62	66	2.4	2.6	54	157	519	1050	397	129	2095	45
50	58	63	2.3	2.5	52	153	487	997	371	122	1977	50
45	55	59	2.1	2.3	48	148	458	944	347	115	1864	45
40	51	56	2.0	2.2	46	143	431	893	324	108	1756	40
35	49	54	1.9	2.1	42	138	405	841	302	104	1652	35
30	46	50	1.8	1.9	38	133	375	792	279	97	1543	30
25	43	47	1.7	1.8	36	129	347	741	254	91	1433	25
20	40	43	1.6	1.7	34	123	316	687	230	84	1317	20
15	36	39	1.4	1.6	30	116	282	630	204	76	1192	15
10	32	35	1.2	1.4	26	107	241	559	174	68	1042	10
5	28	29	1.0	1.2	20	95	185	462	137	57	841	5
3	24	26	.9	1.	20	83	152	395	114	50	713	3
2	22	24	.7	1.	20	72	128	351	92	46	617	2
1	13	18	.5	.8	12	58	84	221	66	31	402	1

Sept. 1, 1892.

May 5, 1892.

Apr. 6 1892.

Strength Measurements of Miss D. W. *Taken* Apr. 6, 1892, May 25, 1892, Sept. 1, 1892, ________ 189__, by M. M. C., J. M. P. A. E. J.

FIG. 34.

whose total strength capacity is 10,000 pounds, corresponding very nearly to the greatest capacity shown upon my table, prepared from two hundred young men in vigorous health. I have undertaken to establish a definite relation between the strength capacity and the total amount of work to be performed. This is accomplished by simply dividing the total amount of work done by the total capacity of the muscles; that is, 1,800,000 is divided by 10,000, giving 180. In other words, for each pound of capacity the muscles are capable of doing 180 foot pounds of work daily, an interesting physiological fact thus for the first time determined. One-sixth of 180 is 30. Hence it is clear that in a symmetrically developed man, with a total strength capacity of 10,000 pounds, each muscle, in order to do its proportion of the 300,000 foot pounds prescribed, must do work to the amount of 30 times its lifting capacity represented in foot pounds.

"It is only necessary, then, in order to ascertain the exact amount of work to be done by each group of muscles at each level, to multiply by thirty the figures of each column of the chart.

"I have made a careful approximate calculation of the amount of work done in each exercise or set of exercises, with each apparatus in the gymnasium under my supervision. It is necessary to know the strength of the medicine, as well as the needs of the patient. Knowing the amount of work required for each individual and for each set of muscles, and also the result obtained from each exercise, it is easy to construct tables of exercises exactly adapted to any capacity. I have arranged ten series of such tables, or day's orders, five for each of the two charts.

"In making a prescription for exercises, I first note the total capacity of the individual, and then write down a number indicating the day's order which would secure for an individual of the given capacity the proper

amount of work. Then glancing over the chart I note the low point, and check or underscore each of these, which indicates to the assistant who superintends the exercise in the gymnasium, that the work is to be doubled on all such points, so as to secure to the weak muscles such rapid development and growth as will enable them to overtake the rest of the muscles and thus restore muscular symmetry. In practice, I find that this method never results in giving to a muscle more than a full day's work and consequently there is no danger of injury resulting from this doubling of the amount of work to be done by the weak muscles. In case of complete paralysis of the muscle, it is of course necessary, at the beginning, to administer the exercise by electrical or mechanical means.

"As a rule I find it sufficient for practical purposes to divide the series of total capacities represented upon my table into five groups, instead of making a distinct schedule of work at each of the levels indicated by the several quantities representing total muscular capacity.

"The ratio which I have established between the muscular capacity and the day's work is probably too small for those in vigorous health; but I find it well suited for the class of persons coming under my observation who are, for the most part, invalids or semi-invalids. The man who is training and desired to develop his whole body to its highest capacity, should be required to execute a full day's work—1,800,000 foot pounds or even more. In arranging a day's order of exercise, due account is of course taken of the work done in walking, running and similar exercises, which may be made part of the program.

"The patient does not undertake the first day to do all the exercises prescribed in the series, but gradually takes them up from day to day, as he learns them, and becomes

able to do them, and by the end of two or three weeks he is expected to have thoroughly mastered all the exercises given him, and to have become able to take each time all that is directed in his prescription. At the end of another month another chart is made, the changes noted and a new prescription prepared according to the requirements. It is a matter of frequent observation that the points which at the first examination are lowest on the chart, are so improved by the specific exercise directed to these particularly weak muscles that they become the highest one upon the second chart."

A study of proportional strength tests and the increase during one year among women in their twentieth year, representing the records of one hundred Smith College students, is presented in the following table prepared by Miss Berenson:

Per Cent.	Back 1	Back 2	Leg 1	Leg 2	Chest 1	Chest 2	R't Forearm 1	R't Forearm 2	L't Forearm 1	L't Forearm 2	L'g Capacity 1	L'g Capacity 2
5	33.5	62	46.5	74.1	14.3	20.5	13.5	18	11	16	1.8	2.1
10	36 3	70.2	50	78.9	16	23	16.2	19.5	12.6	17 4	1.9	2.2
20	42.5	72.3	56.5	87.1	18.8	25.3	17.1	22	15	19.3	2.08	2.3
30	48.9	74.5	62.8	94.9	20 2	26.5	18.8	23.8	16.5	20 4	2.2	2.48
40	54	77	68	101.5	21.1	27.7	20	24.7	17.5	21	2.3	2.57
50	58 5	80	72.1	106	22	28.8	21.1	25	18.5	21 9	2.39	2.66
40	61.5	85	77	111	23.3	30	22.5	25 5	19.4	23	2.4	2.7
30	64.2	89.5	83	117	24.9	31 2	23.7	27.5	20.5	24.3	2.5	2.8
20	68.8	94	88.9	123.9	27	32.9	25.4	29.1	21.5	26	2.6	2.9
10	81	100.5	94.9	136	29.5	35.5	28	32.1	23.5	29	2.7	3.1
5	87.6	103.5	100.5	162	31.5	37	29.5	35.5	25.6	31.5	2.8	3.29

The numbers 1 and 2 placed after the items indicate the first and second measurements respectively, the second being taken after an interval of nine months. The figures represent kilograms and liters. It is interesting to note that the absolute increase for

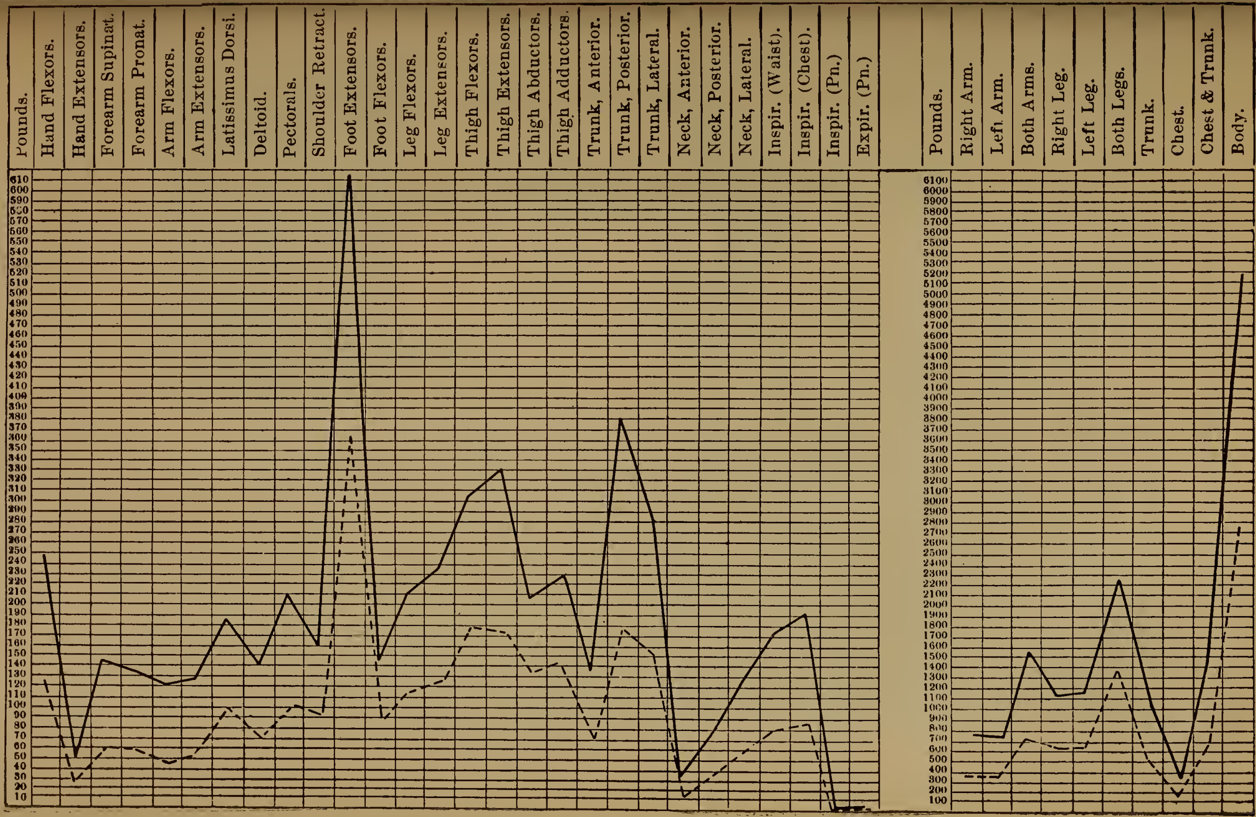

Pounds.
Hand Flexors.
Hand Extensors.
Forearm Supinat.
Forearm Pronat.
Arm Flexors.
Arm Extensors.
Latissimus Dorsi.
Deltoid.
Pectorals.
Shoulder Retract.
Foot Extensors.
Foot Flexors.
Leg Flexors.
Leg Extensors.
Thigh Flexors.
Thigh Extensors.
Thigh Abductors.
Thigh Adductors.
Trunk, Anterior.
Trunk, Posterior.
Trunk, Lateral.
Neck, Anterior.
Neck, Posterior.
Neck, Lateral.
Inspir. (Waist).
Inspir. (Chest).
Inspir. (Pn.)
Expir. (Pn.)
Pounds.
Right Arm.
Left Arm.
Both Arms.
Right Leg.
Left Leg.
Both Legs.
Trunk.
Chest.
Chest & Trunk.
Body.

FIG. 35.

the students strong at the beginning of the year is essentially the same as for the weaker students, and for those of medium grade, although the proportional increase for the weaker students is greater. It would be a great help to the more complete study of methods of physical education, if such records as this from Smith College could be secured for the whole group of students, and for every year during the college course. Somewhat similar reports have been issued from Wellesley and Oberlin Colleges, but here the whole group is included (see pages 102 and 103).

Foster states that the strength of men and women bear the relation of 9 to 5. A more complete comparison is made by Dr. Kellogg in the graphic plate (Fig. 35) which shows the average strength values for the various muscular groups of both men and women.

CHAPTER VI.

SPECIAL INSTRUMENTS.

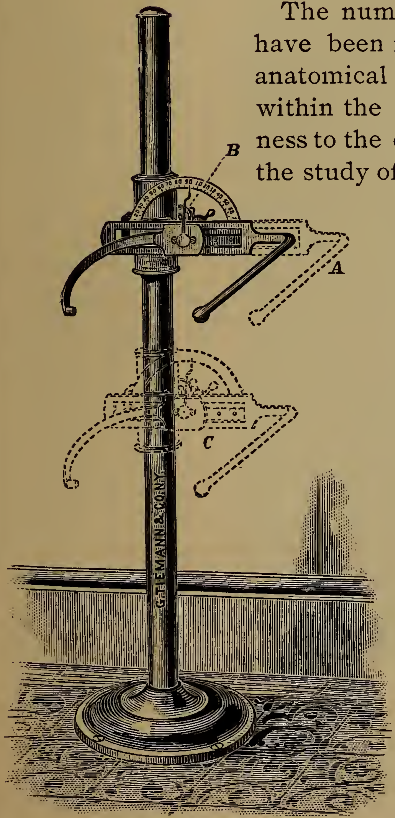


FIG. 36.

The number of instruments that have been invented to demonstrate anatomical and physiological facts within the past ten years bears witness to the extent and earnestness of the study of the human body. Only the principal ones can be described here and that briefly.

An instrument for measuring the obliquity of the pelvis has been invented by Dr. Mosher which is of especial value to those examiners who are working with women. It has been demonstrated by gynecologists that the position of the brim of the pelvis as regards perpendicularity has a very important bearing on the health of the pelvic organs. The mechanical reason for this is apparent to all. To measure and determine what may be considered the normal position and what limits may be considered safe variations from this normal is the

province of those who have charge of the hygiene and physical training of women. The obliquimeter enables the examiner to determine the angle of pelvic tip with accuracy and at small cost of time and effort. The instrument as shown in Fig. 36 consists essentially of a fixed arm that can be adjusted to the height of the individual. A second arm, *A.*, movable upon a pivot, carries a pointer that sweeps over a graduated semicircle. The person to be tested stands in an ordinary posture, the fixed arm of the instrument is placed at the junction of the sacrum and the last dorsal vertebra. The movable arm is then swung down until it rests

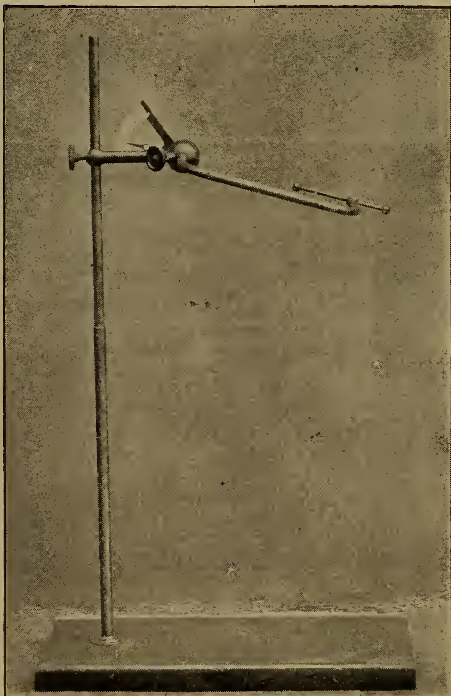


FIG. 37.

upon the pubic symphysis. The reading is then made in degrees as indicated by the pointer. A similar instrument has been invented by Dr. J. H. Kellogg (Fig. 37). It is based on similar mechanical principles, but is somewhat simpler in its mechanism. Probably the amount of pelvic tip is of less importance in men, although its

relation to congestive conditions, hemorrhoids, etc., may yet be demonstrated.

The measurement and abnormalities of the spinal contour has been for many years a somewhat perplexing study, and the various devices that have been originated have nearly all been laid aside as too inaccurate in their results or too complicated in their management to be of high utility. An instrument was devised by G. Demeny, of Paris, which he called a thoracometer, for showing the exact contour of the chest at any level. This instrument, is made in two segments that can be clasped firmly together around the trunk. Running through the band and supported by it are many little rods that are pressed forward, each by a spring, and that are held in any position by a single clamp that acts on all at the same time. The instrument is mounted on a stand so that it can be raised or lowered to be accommodated to any height. The rods are all pushed backward and clamped. The instrument is then placed upon the chest the clamp is released and the springs carry the rods forward until the tips rest against the surface of the thorax. The clamp is now applied and the instrument removed, laid over a sheet of paper and the position of the points of the rods marked with a pencil. These dots are then connected, and the exact contour of the chest is shown.

A second instrument was subsequently devised by the same person for tracing the antero-posterior depths at all points of the trunk. This instrument consists essentially of two small wheels that pass one along the spinous processes while the other passes down the median line in front. These wheels are mounted upon a frame work that carries pencils that mark the outline traversed by the wheels. Obviously this instrument can be used for demonstrating changes in outline during respiration. The thoracometer described above is made on the same

mechanical principle as a more elaborate machine, invented by Zander of Stockholm, for making an outline of the body at any level. It is, however, much simpler and equally efficient.

Instruments for recording outlines of the body have been devised by Drs. J. H. Kellogg,* C. L. Scudder,† and the author. The former secured a full size outline of the body by placing the person in a framework for support while on this framework slides, carrying pencils on arms movable in one direction, were made to travel up

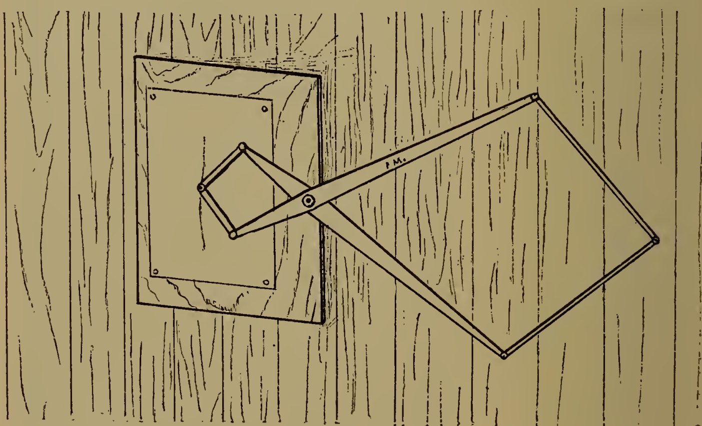


FIG. 38.

and down keeping one extremity in contact with the body. Some very satisfactory results have been obtained by the use of this instrument, as shown by the series of outline drawings of the human form issued by Dr. Kellogg. The device of the author was prepared in 1892 and was exhibited at the meeting of the American Association for the Advancement of Physical Education in Philadelphia, in April of the same year, as a means of giving a

* See Transactions of Amer. Ass'n of Obs. and Gyn., 1890.

† Bost. Med. and Sur. Jour., 1891.

reduced and exact outline of spinal curves both lateral and antero-posterior.

The instrument is based upon the principle of the pantograph. The form is that of a double trapezium (Fig. 38). One extremity carrying a marker and the other a pointer for following the surface to be outlined. The proportional relations are such that the instrument produces a drawing one-third the size of the object that is outlined. This being a convenient size for reference and preservation. The pantograph is hung upon a swinging tablet that is placed at such a height as to make it available for receiving the outline of any part of the body. The person to be outlined is placed in a frame and movable supports are brought against him, at shoulders and hips so that he may not move while the outline is being made, which requires only a few seconds. The instrument will be found useful in making records of the special

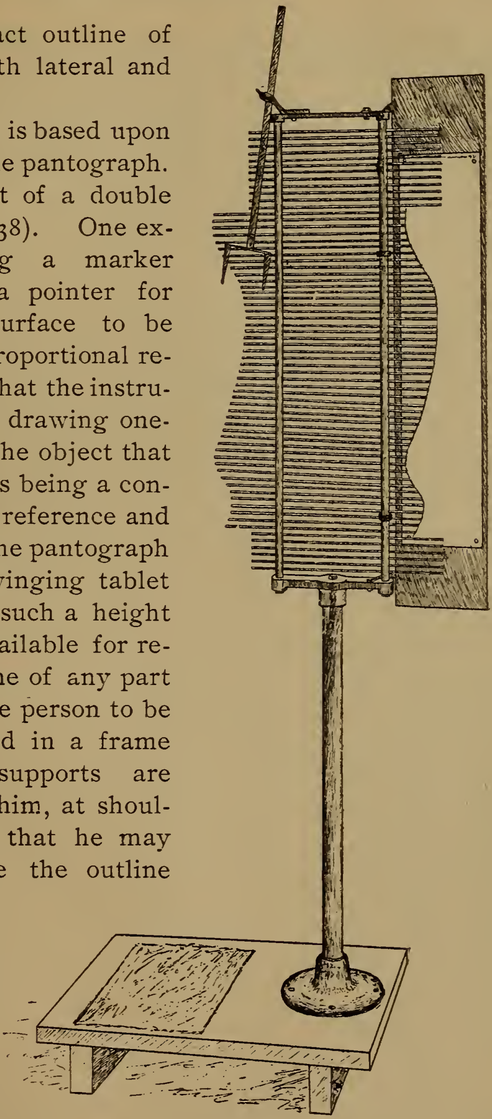


FIG. 39.

cases of deformity that may be under observation. Improvements on the instruments there shown have been made by W. S. Jackson and the author. The instrument may now be said to have some utility in securing outlines of the trunk and of the spinal column.

A method of recording abnormalities of spinal curvature has been invented by Thomas Elkinton of Philadelphia, Fig. 39. It consists of a frame the length of the spinal column. This frame carries a series of rods that are freely movable back and forth. The frame is supported by an adjustable stand so that it may be adapted to the height of any individual. The person stands in customary attitude and is supported there by a fork-shaped support that is applied to the shoulders. The rods are then pushed forward until their ends strike against the spinous processes throughout the entire spinal column. The other ends of the rods play over a sheet of paper and their position is marked by a pencil, thus giving a series of dots that may be connected and an outline of the antero-posterior curves secured. If at any particular level there be any lateral deviation this may be measured horizontally and indicated by a figure on the chart at the level where the deviation occurs, and these may then be laid off to the right and left of a perpendicular line and the displacement shown graphically. An instrument somewhat similar has been made by the author to demonstrate chest movements during respiration, three rods only being used, and these being pushed forward by a spring so that they follow the movement of the wall to which they are applied. The other end of each rod carries a marker that indicates the excursion of the rod.

In connection with instruments for recording abnormal deviations of the spinal column it will be well to call attention to such instruments as have been designed to

give us subsidiary information in regard to the possible cause of the curvature. It has been noted by examiners that in about three-fourths of the cases of curvature of the spine there is a decided difference in the elevation of the iliac crests. This difference may be readily noticed by observation of the difference in waist curve on the two sides, the greater projection of one hip, and the difference in level of the superior spinous processes, both anterior and posterior.

It may be stated in this connection that apparent departures of the pelvis from the normal level do not always indicate a difference in the lengths of the two legs, as it may be caused by pelvic distocia or even by prolonged abnormal posture. However, so far as scoliotic curves are concerned they may properly be attributed to the uneven base of support that is furnished by the laterally tilted pelvis when there is a difference in the height in the two sides of the pelvis. It becomes then the duty of the examiner to recognize any failure in lateral symmetry of bone lengths and to record as far as possible his observations, for if the scoliosis be occasioned mechanically a mechanical remedy will prove efficient and will be, in most cases, the only one indicated. To measure the exact length of the two lower extremities is not an easy matter, and different methods have been suggested to accomplish this end; that employed by surgeons has been to measure with a tape line from the anterior superior spinous process of the ilium to the internal malleolus.

Also to measure to the external malleolus and from the umbilicus to the internal malleolus on either side. It is essential in taking these measurements that the examiner do not retain a position on the tape in passing from one side to the other, and also that he do not look at the reading on the tape until the exact position is determined and the tape removed. To discover the spinous pro-

cess the finger should be pressed well down to the lower edge of the prominence where a well defined point or hook-like projection will be found. In no other way can a true landmark be found.

A test of the accuracy of the ordinary surgical method of measuring the length of leg from the spinous process to the malleolus has been made by Prof. Thomas Dwight, M.D., of the Harvard Medical School.* The measurements were made on the cadaver and after dissection the actual length of the bones was determined. He found that the error was less than 3 mm. in 41 per cent. of the cases, and that an error as large 1 cm. was made in only 7 per cent of the cases. The probable error is, therefore, very small when the examiner is careful and expert in locating the exact points of measurement.

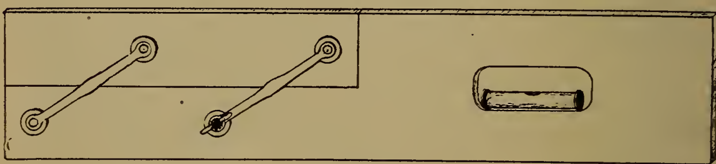


FIG. 40.

A landmark to which attention has been called by anatomists is the comparative height of the gluteal folds on the two sides. The value of this record is suggestive rather than accurate, for it is found that there is not absolute uniformity of the folds in persons where no pelvic tip can be demonstrated, but it may be stated that in all cases where there is an inequality in the length of legs there will be an unevenness in the heights of the folds. A simple instrument for measuring this unevenness has been devised by Thomas Elkinton. It consists of a ruler with a level attached to it and having a a parallel ruler of half the length attached to it, as seen

* Boston "Med. and Sur. Jour.," Vol. CXXXII., No. 18.

in Fig. 40. The ruler is held horizontally so that the upper surface touches the lower gluteal fold. The parallel portion is then moved upward until it touches the higher fold, and the difference in the heights of the two portions may be readily measured and recorded. The same person has also suggested a simple means of measuring the comparative length of the legs by having the subject lie carefully upon a line so that it shall pass between heels and along the spinous processes to the middle of the occiput. Two light box-like supports are then placed under the legs and are pressed firmly against the sole of each foot with equal pressure on either side. A difference in the length of the extremities will be indicated by a projection of the support on the longer side, and can readily be measured by a ruler. The method is simple but will not record accurately the total difference in length, probably because of the partial fixation of the pelvis in a somewhat tilted position by the long continued posture that has been necessitated.

The author has found that a difference in the height of the pelvic crests may usually be determined by having an assistant press two narrow rulers inward and downward upon the sides of the person just above the iliac bones and then measure to the under surfaces of the rulers.

It is not claimed that this gives a true indication of the absolute amount of elevation that will be required under the low side to render the support of the spinal column horizontal. A second method that is suggested is a ruler carrying a level that is affixed to the caliper section of the measuring pole used by the author as shown in Fig. 41. The caliper is applied by pressing its arms firmly upon the tops of the iliac crests while the person stands in normal position bearing the weight equally on each leg. The free end of the ruler is now elevated until it is horizontal. The pelvic tip can then be read in

terms of an angle, or in terms of linear units by measuring the divergence of the end of the ruler, which is made the length of the average pelvic breadth. Probably all that can be claimed for this latter method as an advantage over other methods is the ease with which the record is taken, both for the examiner and the subject.

FIG 41.

Dr. Wilson has made a platform easily adjustable in height by a screw and is accustomed to place the subject with the foot of the low side resting on this platform. He then raises the platform until the pelvis is horizontal. The elevation of the platform gives an indication of the amount of artificial elevation that should be applied to overcome the scoliosis.

An instrument for recording the bilateral movement of the chest in ordinary or forced respiration has been invented by Richard Hogner, M.D.* The instrument is applied somewhat like an ordinary tape at the level at which the movements of the chest are to be recorded. The only advantage of the instrument, over the thoracometer of Demeny, lies in its adjustability to a higher region of the thorax, but the circuitous route that the tapes traverse in reaching the upper thorax invalidates the records made so that the instrument has not come into general use.

*N. Y. "Med. Rec.," Vol. XL., No. 9.

CHAPTER VII.

GRAPHIC ANTHROPOMETRY.

Within the last ten years various devices for applying the principles of graphic mathematics to the measures and tests of men have been invented. These have been the outgrowth of the graphic method of Quetelet for showing the mean of any part, as chest girth or height, and the tables of averages and means published from time to time during the last twenty-five years by Dr. Hitchcock of Amherst, and the tables of percentages published by Francis Galton and other students of anthropology.

The oldest record of anthropometrical data in any college in the country is to be found at Amherst, where from 1861–2 to this date the students have had the advantage of a physical examination, and advice regarding exercise, and a record of their general size has been secured.

In 1867 W. T. Brigham of Boston made a study of the proportions of Mongolian emigrants.* In 1869 he began to take the measurements of American young men and for this purpose used a list of measurements and records that was later adopted in essential form as the list of the American Association. He measured several hundred Harvard students and other men, but never published his data.

The items given in Dr. Hitchcock's list are extended in the record book of Yale by the addition of age, breadth of chest, development, condition, exercise, vision, hearing, color of hair and eyes, pulse rate, and use of tobacco. The horizontal length is omitted. It may be

*Proc. Bost. Nat Hist. Soc'y., 1867.

said that at Amherst the record of each student is transcribed for him on a table that is compiled from the measurements of men of the same height. The table here shown on the opposite page gives the averages obtained from five colleges, the material having been obtained by one man in each institution.

In 1880 Dr. D. A. Sargent of Harvard began a systematic record of measurements of students examined by himself. He has endeavored to determine a physical standard for American college students that should be derived from a tabulation of all the measurements that could be secured. The work was very comprehensive in scope and the main results have not yet been given to the public, but a partial result has been seen in the graphic chart that was prepared in 1886 (Fig. 42) by which he was able to give a person an idea of how he compared with the whole body of students whose measures had been tabulated. A second result was seen in the July and November numbers of "Scribner's Magazine" for 1887, where, in an article on "The Physical Characteristics of the Athlete," certain well-known men were pictured graphically as well as literally, and thus the application of the method was more clearly impressed on the minds of persons engaged in physical education.

Meanwhile Dr. Hitchcock of Amherst College, who had published tables of average measurements of Amherst students of all ages, from fifteen up to twenty-eight years, and tables of averages where height instead of age was the basis of tabulation, issued a table in which the latter averages were arranged on a sheet in order from shortest to tallest, by gradation, of one centimeter, and the records of an ordinary person could be indicated on this new table in a graphic way. In 1887 an "adjusted averages" table was prepared as a simple acknowledgment that the tables were compiled

AVERAGES OF COLLEGE STUDENTS.

	Amherst.	Cornell.	Wisconsin.	Yale.	W. & J.
AGE,	20.8	—	20.1	20.3	—
WEIGHT,	61.2	61.2	63.3	63.	63.1
HEIGHT,	1725	1725	1726	1724	1730
" Sternum,	1410	1406	1415	1416	—
" Navel,	1030	1030	1030	1033	—
" Pubis,	860	859	864	860	—
" Sitting,	903	904	903	903	895
" Knee,	478	424	451	448	—
LENGTH, Should., Elb.	369	373	370	372	—
" Elb. to Tip,	460	461	462	461	—
" Arm Reach,	1780	1782	1792	1790	—
" R. Foot,	260	258	260	258	—
" L. Foot,	259	258	260	258	—
GIRTH, Head,	572	570	575	570	—
" Neck,	353	349	357	350	346
" Chest, dep.	—	—	839	846	846
" " inf.	926	929	934	924	910
" " nor.	880	884	878	875	—
" " at 9th Rib full,	—	—	—	887	—
" " " " " dep.	—	—	—	824	—
" Waist,	723	726	731	725	719
" Hips,	893	895	904	888	888
" R. Biceps,	295	298	300	293	293
" L. Biceps,	—	—	292	283	285
" R. Arm,	260	258	259	256	256
" L. Arm,	258	251	256	248	250
" R. Elbow,	251	251	231	229	—
" L. Elbow,	247	246	229	224	—
" R. Forearm,	267	258	265	264	265
" L. Forearm,	261	258	259	258	258
" R. Wrist,	166	165	169	165	165
" L. Wrist,	164	164	167	164	—
" R. Thigh,	520	513	524	515	507
" L. Thigh,	517	511	522	513	501
" R. Knee,	361	359	362	357	—
" L. Knee,	359	357	359	359	—
" R. Calf,	349	354	352	350	339
" L. Calf,	349	348	350	350	339
" R. Instep,	241	242	240	233	—
" L. Instep,	239	240	239	234	—
BREADTH, Head,	155	154	156	155	—
" Neck,	108	107	107	107	—
" Shoulders,	430	434	435	410	415
" Chest,	—	—	279	273	270
" Waist,	254	252	251	253	—
" Hips,	323	323	325	323	319
DEPTH, Chest,	—	—	187	186	184
" Abdomen,	—	—	181	182	—
CAPACITY, Lungs,	3.78	4 24	4.05	4.00	4.05
STRENGTH of Back,	138	—	—	150	—
" Legs,	164	—	—	181	—
" R. Forearm,	40	—	56.8	54	57.3
" L. Forearm,	37	—	54.5	47	50.4
" Pull Up,	9.5	—	—	—	—
" Push Up.	6.	—	—	—	—

DEVELOPMENT,
CONDITION,
EXERCISE,
VISION, R. Eye,
" L. Eye,

HEARING,
COLOR of Hair,
" " Eyes,
PULSE,
TOBACCO,

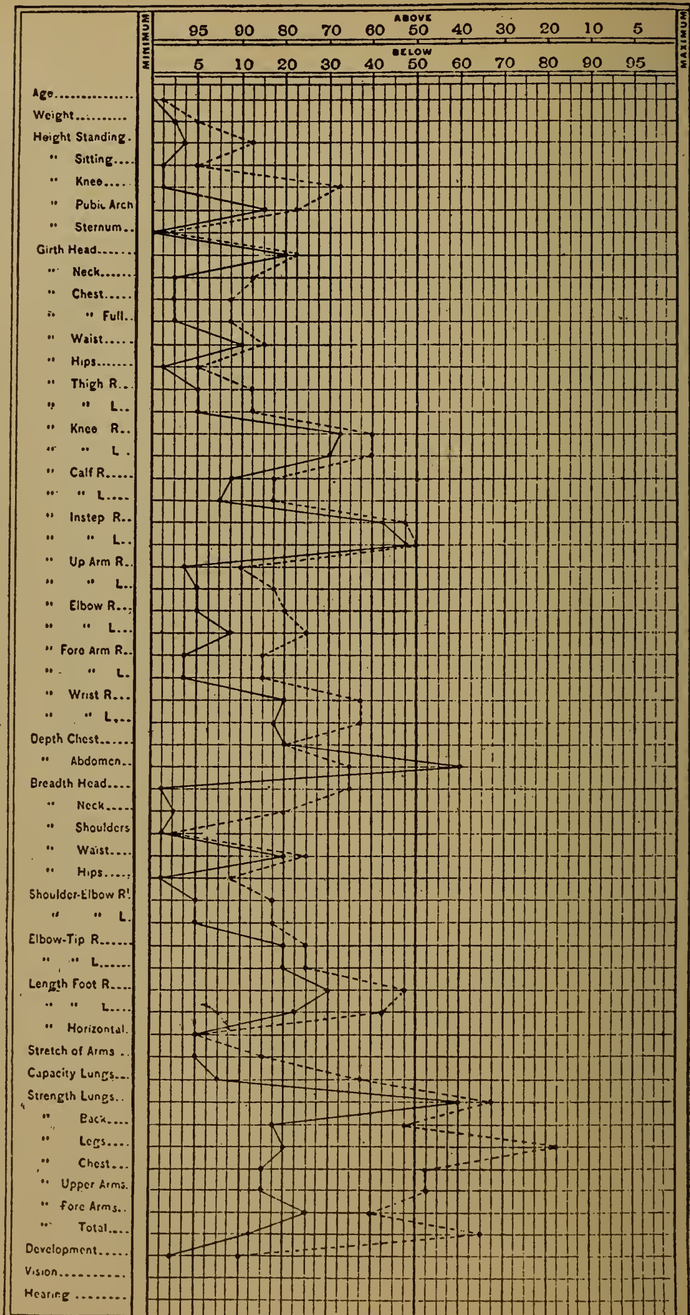


FIG. 42. Copyright, 1886, by D. A. Sargent.

from so few records in many cases that there was considerable irregularity, and therefore after determining the apparent law of variation, the table was made to conform more or less closely to this law, and a better sheet for graphic illustration was produced. The numerical comparison method that has been in use at Amherst for over thirty years has given us the most extensive study of young men from sixteen to twenty-five years of age that we have (see page 105). The tables compiled by Dr. Hitchcock are the most complete in existence in this country, the records all having been taken by one man.

In 1888 the measurements of Yale students for five years, that had been taken by the author and that included every man in the undergraduate departments for three years and of two other academical classes, except three men, for four years, altogether the records of over 2,200 men, were compiled and arranged in tabular form according to the method of Mr. Galton (see Fig. 43).

This has furnished a table for graphic illustration and personal information that is fairly complete. It combines (*a*) the comparison of a man's records with those of the whole mass of students; (*b*) a comparison with the *mean;* (*c*) the statement of the actual numerical size of each part of an individual, and (*d*) its relation to every other part.

The general form of this table has been found to be more satisfactory than any other that has been devised, and it has been followed in form by Dr. Hitchcock, Miss Wood, and Dr. Hanna of Oberlin, and, with slight modifications, by Dr. Gulick (Fig. 44), Dr. Garland and Dr. Pfister. Dr. Baker of Washington and Jefferson College has also slightly modified the form, while maintaining its general features.

This percentile table (Fig. 43), issued in the Spring of

PER CENT.	AGE.	WEIGHT.	HEIGHT. Height.	HEIGHT. Sternum.	HEIGHT. Navel.	HEIGHT. Pubis.	HEIGHT. Sitting.	HEIGHT. Knee.	GIRTH. Head.	GIRTH. Neck.	GIRTH. Chest nor.	GIRTH. Chest inf.	GIRTH. Waist.	GIRTH. Hips.
1	27.	86.1 190	1876 73.8	1546 60.8	1146 45.1	956 37.6	986 38.8	494 19.5	600 23.6	397 15.7	1005 39.5	1060 41.8	857 33.7	1046 41.2
2.5	25.5	81.1 179	1849 72.7	1524 60	1125 44.3	936 36.8	971 38.3	486 19.1	596 23.5	386 15.2	970 38.2	1025 40.4	833 32.8	1000 39.4
5	24.	77. 170	1827 71.9	1506 59.2	1110 43.7	925 36.4	960 37.8	477 18.8	592 23.3	379 14.9	951 37.4	1005 39.5	810 31.9	974 38.4
10	22.6	74.4 164	1805 71.	1490 58.6	1096 43.1	910 35.8	952 37.5	472 18.6	588 23.2	372 14.6	930 36.6	980 38.6	790 31.1	953 37.5
15	21.10	72.1 159	1790 70.4	1476 58.1	1084 42.6	900 35.4	944 37.2	467 18.4	583 23.	368 14.5	915 36.	96[illegible] 38.	779 30.7	943 37.1
20	21.4	69.4 153	1775 69.8	1464 57.6	1074 42.2	891 35.1	938 36.9	463 18.[illegible]	580 22.8	365 14.4	905 35.6	955 37.6	760 30.3	934 36.8
25	20.11	68.5 151	1765 69.5	1452 57.1	1065 41.9	884 34.7	932 36.[illegible]	459 18.1	578 22.7	362 14.3	895 35.3	946 37.3	761 30.	924 36.4
30	20.7	67.6 149	1754 69	1443 56.7	1057 41.6	877 34.5	927 36.5	456 18.	575 22.6	360 14.2	888 35.	938 36.9	754 [illegible]	918 36.1
35	20.3	67.[illegible] 145	1746 68.7	1435 56.5	1051 41.4	871 34.3	922 36.3	453 17.9	573 22.5	357 14.1	881 34.7	930 36.6	747 29.4	912 35.9
40	20.	64.9 143	17[illegible] 68.4	1427 [illegible]	1045 [illegible]	866 34.1	917 36.1	450 17.7	571 22.5	354 14.	875 34.5	923 36.3	741 29.2	906 35.7
45	19.9	63.5 140	1730 68.1	1420 55.9	1039 40.9	860 33.8	913 35.9	448 17.7	569 22.4	352 13.9	868 34.1	916 36.1	735 29.	900 35.4
50	19.7	63.1 139	1724 67.8	1415 55.7	1033 40.6	855 33.6	910 35.8	446 17.6	568 22.3	350 13.8	861 33.9	910 35.8	730 28.[illegible]	896 35.3
45	19.6	61.[illegible] 1[illegible]6	1717 67.5	1410 55.5	1027 40.4	850 33.5	907 35.7	441 17.5	567 22.3	345 13.7	854 33.6	904 35.6	725 28.5	891 35.
40	19.4	60.8 134	1710 67.[illegible]	1403 55.2	1022 40.2	844 33.2	903 35.6	442 17.4	565 22.2	346 13.6	848 33.4	898 35.4	719 28.3	885 34.8
35	19.1	59.4 131	1702 67.	1396 55	1017 40	840 33.1	899 35.4	439 17.3	564 22.2	343 13.5	842 33.1	892 35.1	713 28.1	880 34.6
30	18.10	58.5 129	1695 66.7	1388 54.6	1010 39.7	835 32.9	895 35.2	436 17.2	562 22.1	341 13.4	836 32.9	884 34.8	707 27.8	874 34.4
25	18.6	57.6 127	1687 66.4	1380 54.3	1004 39.5	829 32.6	890 35.	433 17.	560 22.	339 13.3	828 32.6	877 34.5	701 27.6	867 34.1
20	18.3	57. 125	1676 65.9	1371 54.	997 39.2	823 32.4	884 34.8	430 16.9	558 21.9	337 13.3	819 32.3	868 34.2	695 27.4	860 33.9
15	18.	55.4 122	1664 65.5	1360 53.5	986 38.8	815 32.1	876 34.5	426 16.8	555 21.8	333 13.1	810 31.9	858 33.7	686 27.	852 33.5
10	17.8	53.5 118	1645 64.7	1345 52.9	974 38.4	806 31.7	868 34.2	422 16.6	550 21.6	329 13.	800 31.5	846 33.3	677 26.7	841 33.1
5	17.3	51.3 113	1626 64	1325 52.1	958 37.7	794 31.2	854 33.6	418 16.5	545 21.5	324 12.8	784 30.8	826 32.5	661 26.	828 32.6
2.5	17.1	49.4 109	1605 63.2	1314 51.7	947 37.3	780 30.7	842 33.1	414 16.3	540 21.3	318 12.5	766 30.1	812 32.	644 25.4	814 32.
1	16.7	45.4 100	1576 62	1290 50.8	931 36.2	765 30.1	826 32.5	403 15.9	535 21.	311 12.2	740 29.1	787 31.	595 24.5	794 31.3

PER CENT.	GIRTH. Biceps.	R. Arm.	L. Arm.	R. Elbow.	L. Elbow.	R.Forearm	L.Forearm	R. Wrist.	L. Wrist.	R. Thigh.	L. Thigh.	R. Knee.	L. Knee.	R. Calf.	L. Calf.	R. Instep.	L. Instep.
1	363 14.3	315 12.4	310 12.2	272 10.7	288 10.6	302 11.7	295 11.6	183 7.2	182 7.2	616 24.3	814 24.2	404 15.9	403 15.9	406 16.	407 16.	260 10.3	260 10.3
2.5	348 13.7	298 11.7	293 11.5	263 10.4	258 10.2	293 11.5	285 11.2	180 7.1	178 7.	593 23.4	586 23.1	394 15.5	394 15.5	395 15.6	397 15.6	256 10.1	256 10.1
5	337 13.2	290 11.4	284 11.2	255 10.1	250 9.8	288 11.3	280 11.	176 6.9	175 6.9	577 22.7	570 22.4	385 15.2	385 15.2	386 15.2	388 15.3	252 10.	252 10.
10	327 12.9	282 11.1	275 11.	249 9.8	245 9.7	282 11.1	275 10.8	178 6.8	172 6.8	560 22.	554 21.8	379 14.9	379 14.9	377 14.8	377 14.8	247 9.7	248 9.7
15	321 12.6	276 10.9	270 10.7	245 9.7	241 9.5	278 11	271 10.7	171 6.7	170 6.7	551 21.7	544 21.4	373 14.7	373 14.7	37[illegible] 14.7	372 14.7	243 9.6	244 9.6
20	315 12.4	272 10.7	266 10.5	242 9.5	238 9.4	275 10.9	268 10.5	170 6.7	169 6.7	544 21.4	538 21.2	368 14.5	370 14.6	368 14.5	368 14.5	241 9.5	242 9.5
25	311 12.3	268 10.6	262 10.3	239 9.4	235 9.3	272 10.7	265 10.4	169 6.6	168 6.6	538 21.2	532 21	365 14.4	367 14.5	364 14.3	364 14.3	239 9.4	240 9.5
30	308 12.1	265 10.5	259 10.2	237 9.3	232 9.2	270 10.6	263 10.3	168 6.6	167 6.5	534 21.	527 20.7	363 14.3	365 14.4	361 14.2	361 14.2	238 9.4	239 9.4
35	304 12	262 10.4	256 10.1	235 9.3	230 9.1	268 10.5	261 10.3	167 6.5	166 6.5	529 20.8	523 20.6	360 14.2	362 14.3	358 14.1	358 14.1	236 9.3	237 9.3
40	301 11.9	259 10.3	253 10.	233 9.2	228 9.	265 10.5	259 10.2	166 6.5	165 6.5	524 20.6	519 20.4	358 14.1	359 14.2	355 14.	355 14.	234 9.2	235 9.2
45	298 11.7	256 10.1	250 9.9	231 9.1	226 8.9	263 10.4	256 10.1	165 6.5	164 6.4	519 20.4	514 20.3	356 14.	357 14.	352 13.9	352 13.8	233 9.2	234 9.2
50	295 11.6	254 10.	248 9.8	229 9	224 8.8	261 10.3	254 10.	164 6.4	163 6.4	515 20.3	509 20.	354 14.	355 14	350 13.8	350 13.8	231 9.1	232 9.1
45	292 11.5	251 9.9	246 9.7	227 9.	222 8.7	259 10.2	252 9.9	163 6.4	162 6.4	511 20.1	505 19.8	352 13.9	353 13.9	348 13.7	347 13.7	230 9.1	231 9.1
40	288 11.4	248 9.7	242 9.5	225 8.9	220 8.6	257 10.1	250 9.8	162 6.4	161 6.3	507 19.9	501 19.7	350 13.8	351 13.8	345 13.6	344 13.6	229 9.	230 9.
35	285 11.2	245 9.7	240 9.5	222 8.7	218 8.6	255 10.	248 9.8	161 6.3	160 6.3	503 19.8	497 19.6	348 13.7	349 13.7	342 13.5	341 13.5	227 9.	228 9.
30	282 11.1	242 9.5	237 9.4	220 8.6	216 8.5	253 10.	246 9.7	160 6.3	159 6.3	498 19.6	492 19.4	345 13.6	346 13.6	339 13.4	338 13.3	226 8.9	227 9.
25	278 11.	239 9.4	234 9.2	218 8.6	214 8.4	251 9.9	244 9.6	159 6.3	158 6.2	492 19.4	485 19.1	342 13.5	343 13.5	335 13.2	335 13.2	225 8.9	226 8.9
20	273 10.7	236 9.3	231 9.1	215 8.5	211 8.3	249 9.8	242 9.5	158 6.2	157 6.2	486 19.2	480 18.9	339 13.4	340 13.4	331 13.	331 13	223 8.8	224 8.8
15	268 10.6	232 9.1	227 9.	212 8.4	208 8.2	246 9.6	239 9.4	156 6.1	156 6.1	480 18.9	475 18.7	336 13.3	337 13.3	327 12.9	327 12.9	221 8.7	222 8.7
10	262 10.3	227 9.	222 8.8	208 8.2	204 8.	242 9.5	235 9.3	155 6.1	154 6.1	474 18.7	466 18.3	333 13.1	334 13.2	323 12.7	323 12.7	218 8.6	219 8.6
5	255 10.1	222 8.8	217 8.6	203 8.	200 7.8	237 9.3	230 9.1	152 6.	151 6.	462 18.2	455 17.9	326 12.8	327 12.9	316 12.5	316 12.5	216 8.5	216 8.5
2.5	247 9.7	217 8.6	212 8.4	198 7.7	195 7.7	232 9.1	225 8.9	150 5.9	149 5.9	450 17.7	444 17.5	320 12.6	322 12.7	310 12.2	310 12.2	212 8.4	212 8.4
1	240 9.5	210 8.3	205 8.1	194 7.6	191 7.5	226 8.9	220 8.7	148 5.8	147 5.7	437 17.2	432 17.	313 12.3	315 12.4	304 12	304 12.	208 8.2	208 8.2

PER CENT.	BREADTH. Head.	BREADTH. Neck.	BREADTH. Shoulders.	BREADTH. Chest.	BREADTH. Nipples.	BREADTH. Waist.	BREADTH. Hips.	DEPTH. Chest.	DEPTH. Abdomen.	Capacity of Lungs.	Strength of Back.	Strength of Legs.	Strength of Forearm.
1	168 6.5	121 4.8	457 18.	330 13.	232 9.2	300 11.8	363 14.3	225 8.9	225 8.9	5.70 348	229 505	272 600	82 150
2.5	164 6.5	119 4.7	448 17.7	322 12.7	225 8.9	287 11.3	355 14.	215 8.5	214 8.4	5.40 330	220 485	261 575	75 130
5	162 6.4	115 4.5	442 17.4	314 12.4	220 8.7	281 11.1	349 13.8	205 8.[illegible]	204 8.	5.16 315	211 465	2[illegible]7 545	70 120
10	161 6.3	113 4.4	433 17.	306 12.1	216 8.5	274 10.8	344 13.6	199 7.8	201 7.9	4.94 302	195 430	231 510	67 115
15	160 6.3	112 4.4	4[illegible] 16.9	298 11.8	212 8.3	270 10.6	340 13.4	197 7.8	198 7.8	4.76 290	186 410	226 498	65 110
20	159 6.2	111 4.4	424 16.7	293 11.5	208 8.2	267 10.5	337 13.3	195 7.7	194 7.7	4.63 282	179 395	217 478	63 106
25	158 6.2	111 4.4	421 16.6	288 11.3	205 8.1	264 10.4	334 13.2	193 7.6	191 7.5	4.53 273	175 385	211 465	61 102
30	157 6.2	110 4.3	418 16.5	283 11.1	203 8.	262 10.3	331 13.1	191 7.5	188 7.4	4.45 270	171 376	206 454	60 100
35	156 6.1	109 4.3	415 16.4	279 11.	201 7.9	259 10.2	329 13.	190 7.4	186 7.3	4.37 264	167 367	201 442	59 98
40	156 6.1	108 4.3	413 16.3	276 10.9	199 7.8	257 10.1	327 12.9	189 7.4	184 7.3	4.30 261	162 356	195 430	58 96
45	155 6.1	107 4.2	410 16.2	273 10.8	196 7.7	255 10	325 12.8	188 7.4	183 7.2	4.22 258	157 345	191 420	57 94
50	155 6.1	106 4.2	407 16	270 10.7	194 7.7	253 10.	323 12.7	187 7.4	181 7.1	4.15 253	153 338	186 410	56 92
45	155 6.1	105 4.2	405 16.	268 10.6	192 7.6	251 9.9	321 12.7	186 7.3	179 7.	4.07 250	150 330	183 403	55 90
40	154 6.1	105 4.2	402 15.8	265 10.5	190 7.5	249 9.8	319 12.6	184 7.3	178 7	4.00 244	145 320	179 395	53 88
35	153 6.	104 4.1	400 15.8	263 10.4	188 7.4	247 9.7	317 12.5	182 7.2	177 7	3.92 240	140 308	176 387	52 86
30	153 6	103 4.1	397 15.7	261 10.3	186 7.3	245 9.7	315 12.4	180 7.1	175 6.9	3.82 232	135 298	171 376	51 84
25	152 6.	103 4.1	394 15.5	259 10.2	184 7.2	243 9.6	312 13.3	178 7.	174 6.9	3.73 228	130 287	166 365	50 82
20	151 5.9	102 4.	391 15.4	257 10.1	181 7.1	240 9.5	310 12.2	176 6.9	172 6.8	3.62 220	125 275	159 350	49 80
15	150 5.9	101 4.	387 15.3	254 10.	178 7.	237 9.4	307 12.1	173 6.8	170 6.7	3.48 212	120 265	151 332	47 75
10	149 5.9	98 3.9	382 15.1	247 9.8	175 6.9	234 9.2	302 11.9	170 6.7	167 6.6	3.35 205	113 248	144 317	45 70
5	147 5.8	98 3.9	375 14.8	240 9.5	170 6.7	230 9.1	297 11.7	167 6.6	163 6.5	3.13 192	104 230	136 300	43 65
2.5	145 5.7	96 3.8	368 14.5	233 9.2	164 6.5	225 8.9	292 11.5	164 6.5	159 6.3	2.90 178	95 210	125 275	41 60
1	143 5.6	94 3.7	361 14.2	228 9.	160 6.3	220 8.7	286 11.3	160 6.3	152 6.	2.65 162	84 185	114 250	38 55

Per Cents	1	2	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	98	99
Weight	103.3	107.5	113.9	119.5	123.3	126.4	129.	131.3	133.6	135.5	137.5	139.5	141.5	143.5	145.4	147.7	150.	152.6	155.7	159.4	165.1	171.5	175.7
Height	62.6	63.1	63.9	64.7	65.2	65.6	65.8	66.2	66.5	66.7	67.	67.2	67.5	67.8	68.	68.3	68.6	68.9	69.3	69.8	70.5	71.4	71.9
GIRTHS. Neck	12.2	12.4	12.7	13.	13.2	13.4	13.5	13.6	13.7	13.8	13.9	14.	14.1	14.2	14.4	14.5	14.6	14.7	14.9	15.1	15.4	15.7	15.9
Chest Contracted	29.9	30.4	31.2	31.9	32.3	32.7	33.	33.3	33.5	33.8	34.	34.2	34.5	34.7	35.	35.2	35.5	35.8	36.2	36.6	37.3	38.1	38.6
Chest Expanded	32.3	32.9	33.8	34.6	35.2	35.6	36	36.3	36.6	36.9	37.2	37.5	37.8	38.1	38.3	38.7	39	39.4	39.8	40.3	41.2	42.1	42.7
Waist	24.8	25.3	26.2	26.9	27.4	27.8	28.2	28.5	28.8	29.1	29.3	29.6	29.9	30.1	30.4	30.7	31.	31.3	31.7	32.3	33.	33.9	34.4
Right Forearm	9.	9.2	9.4	9.7	9.8	10	10.1	10.2	10.3	10.4	10.5	10.5	10.6	10.7	10.8	10.9	11.	11.1	11.2	11.4	11.6	11.9	12.1
Right Upper Arm Down	8.3	8.6	9.	9.4	9.6	9.8	10.	10.1	10.3	10.4	10.6	10.7	10.8	11.	11.1	11.2	11.4	11.6	11.8	12.	12.4	12.8	13.1
Right Upper Arm Up.	9.9	10.2	10.5	10.9	11.	11.3	11.5	11.6	11.8	11.9	12.	12.1	12.3	12.4	12.5	12.6	12.8	13.	13.1	13.4	13.8	14.1	14.4
Left Forearm	9.	9.2	9.4	9.7	9.8	10.	10.1	10.2	10.3	10.4	10.5	10.5	10.6	10.7	10.8	10.9	11.	11.1	11.2	11.4	11.6	11.9	12.1
Left Upper Arm Down	8.3	8.6	9.	9.4	9.6	9.8	10.	10.1	10.3	10.4	10.6	10.7	10.8	11.	11.1	11.2	11.4	11.6	11.8	12.	12.4	12.8	13.1
Left Upper Arm Up	9.9	10.2	10.5	10.9	11.	11.3	11.5	11.6	11.8	11.9	12.	12.1	12.3	12.4	12.5	12.6	12.8	13.	13.1	13.4	13.8	14.1	14.4
Right Thigh	17.	17.3	17.9	18.4	18.8	19.1	19.3	19.5	19.7	19.9	20.1	20.2	20.4	20.6	20.8	21.	21.2	21.4	21.7	22.	22.6	23.1	23.5
Right Calf	11.6	11.9	12.3	12.6	12.8	13	13.2	13.3	13.5	13.6	13.7	13.8	14.	14.1	14.2	14.3	14.5	14.7	14.8	15.1	15.4	15.8	16.1
Left Thigh	17.	17.3	17.9	18.4	18.8	19.1	19.3	19.5	19.7	19.9	20.1	20.2	20.4	20.6	20.8	21	21.2	21.4	21.7	22.	22.6	23.1	23.5
Left Calf	11.6	11.9	12.3	12.6	12.8	13.	13.2	13.3	13.5	13.6	13.7	13.8	14.	14.1	14.2	14.3	14.5	14.7	14.8	15.1	15.4	15.8	16.1
Dip	0	0	1.2	3.4	4.8	6	7.	7.9	8.7	9.5	10.2	11.	11.8	12.5	13.3	14.1	15.	16.	17.2	18.6	20.8	23.2	24.8
Pull Up	0	0	1.7	3.3	4.4	5.2	6.	6.7	7.3	7.9	8.4	9.	9.6	10.1	10.7	11.3	12.	12.7	13.6	14.7	16.3	18.1	9.3

FIG. 44.

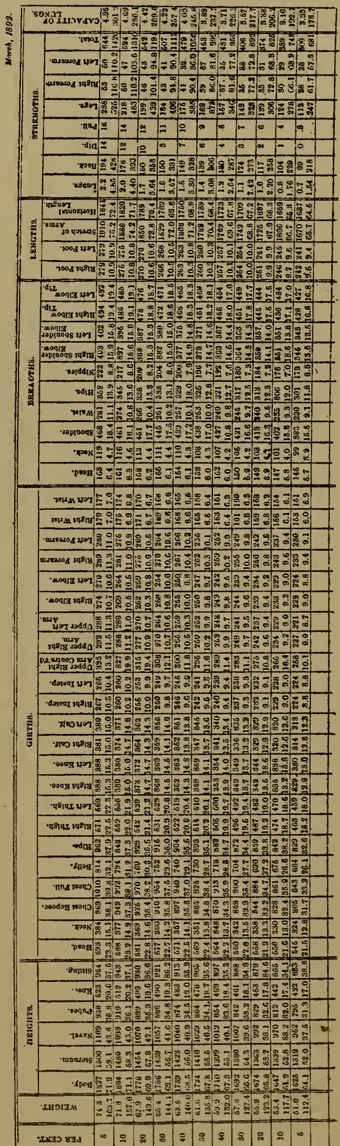


FIG. 45.

1888, was followed in 1891 by a similar table compiled from an almost equal number of men by Dr. Hitchcock of Amherst College (Fig. 45). This table gives an opportunity of comparing the average or mean Amherst student with the mean Yale student, as each table includes all of the group at each college.

It should be remarked that in recording certain dimensions the method varies so as to invalidate the comparison for these items. For instance, the height of knee in the Yale table is the height to the top of the head of the fibula, while in the Amherst table it represents the height to the tendons of the hamstring muscles. The girth of elbows represents in the one case the smallest measurements taken above the condyles of the humerus, while in the other it represents a measurement taken over the condyles. And in breadth of shoulders the record in the one case is bi-acromial, while in the

other it is bi-deltoid. It should also be noted that the strength records are taken with entirely different instruments, and therefore do not represent so close a comparison as do the other records in the table. In the strength of forearm on the Yale table the upper figures represent the readings on the dynamometer, which were supposed to be kilograms and were so marked; while the lower figures in the square represent the actual value of these records in pounds, as determined by a test of the instrument. This instrument was of standard make, and illustrates the unreliability of spring instruments, that have been used heretofore in securing records. The double sets of figures in the various squares in all these tables represent kilograms, millimeters and liters and their respective equivalents in English units.

In 1893 Miss M. Anna Wood of Wellesley College tabulated the measurements of 1,500 students, and issued the table, Fig. 46, in the same form as that of the author. This was followed in 1894 by a similar table, Fig. 47, compiled from the records of 1,600 female students of Oberlin College, taken and compiled by Dr. Delphine Hanna, a professor in the college. The order of items follows the Wellesley form. In both of these cases the tables are of high value as representing the whole of a group, and we may therefore fairly consider that the fifty per cent line represents the average of the students of Wellesley and Oberlin.

An interesting study of the physical type represented in the two institutions may be made by plotting the fifty per cent line, the twenty-five per cent line above the mean and the twenty-five per cent line below the mean of one college upon the table representing the records of the other. In general it will be seen that the Wellesley student is somewhat larger in general dimensions, while the Oberlin student represents more nearly the type that

PER CENT.	AGE.	WEIGHT.	HEIGHT: Height.	Sitting.	Knee.	Pubes.	Navel.	Sternum.	GIRTH: Head.	Neck.	Chest.	Chest full.	Ninth Rib.	Ninth Rib full.	Waist.	Hips.	Thigh R.	Thigh L.
1	27.0	75.3 166.	1725 67.9	917 36.1	458 18	872 34.3	1060 41.7	1415 55.8	593 23.3	348 13.7	849 33.4	904 35.6	755 29.7	807 31.8	742 29.2	1060 41.7	659 25.9	656 25.8
2.5	25.9	71.4 157.3	1710 67.3	905 35.6	451 17.8	854 33.6	1049 41.3	1404 55.3	586 23.1	339 13.3	830 32.7	883 34.8	721 28.4	783 30.8	716 28.1	1025 40.4	637 25.1	634 25.
5	24.3	67.4 148.6	1694 66.7	895 35.2	444 17.5	841 33.1	1036 40.8	1389 54.7	579 22.8	335 13.2	813 32	867 34.1	700 27.6	761 30.	698 27.5	997 39.3	623 24.5	621 24.4
10	22.7	63.7 140.4	1674 65.9	885 34.8	435 17.1	828 32.6	1021 40.2	1374 54.1	574 22.6	330 13.	796 31.3	851 33.5	680 26.8	743 29.3	679 26.7	971 38.2	606 23.9	603 23.7
15	21.10	61.5 135.5	1661 65.4	878 34.6	429 16.9	819 32.2	1011 39.8	1361 53.6	570 22.4	326 12.8	783 30.8	841 33.1	668 26.3	733 28.9	666 26.2	956 37.6	595 23.4	592 23.3
20	21.4	60. 132.2	1652 65.	872 34.3	426 16.8	810 31.9	1003 39.5	1352 53.2	568 22.4	322 12.7	773 30.4	831 32.7	659 25.9	726 28.6	657 25.9	943 37.1	586 23.1	583 23.
25	20.11	58.8 129.6	1642 64.6	867 34.1	422 16.6	804 31.7	997 39.3	1344 52.9	566 22.3	320 12.6	765 30.1	824 32.4	650 25.6	718 28.3	650 25.6	933 36.7	578 22.8	577 22.7
30	20.8	57.8 127.4	1634 64.3	862 33.9	419 16.5	798 31.4	991 39.	1337 52.6	563 22.2	318 12.5	757 29.8	818 32.2	644 25.4	712 28.	645 25.4	923 36.3	572 22.5	571 22.5
35	20.5	56.8 125.1	1627 64.1	858 33.8	417 16.4	793 31.2	985 38.8	1330 52.4	561 22.1	316 12.4	750 29.5	812 32.	639 25.2	706 27.8	639 25.2	914 36.	567 22.3	565 22.2
40	20.2	55.9 123.1	1620 63.8	854 33.6	415 16.3	787 31.	980 38.6	1324 52.1	559 22.	314 12.4	743 29.3	807 31.8	634 25.	701 27.6	634 25.	907 35.7	561 22.1	559 22.
45	20.	54.9 121.1	1612 63.5	850 33.5	413 16.3	783 30.8	974 38.3	1318 51.9	558 22.	314 12.3	737 29.	802 31.6	629 24.8	695 27.4	629 24.8	901 35.5	555 21.9	553 21.8
50	19.10	54.2 119.4	1605 63.2	840 33.3	410 16.1	778 30.6	968 38.1	1312 51.7	556 21.9	310 12.2	732 28.8	798 31.4	624 24.6	691 27.2	624 24.6	893 35.2	549 21.6	545 21.6
45	19.8	53.3 117.5	1598 62.9	842 33.1	408 16.1	773 30.4	963 37.9	1306 51.4	554 21.8	308 12.1	725 28.5	793 31.2	619 24.4	687 27.	619 24.4	885 34.8	544 21.4	542 21.3
40	19.5	52.4 115.5	1592 62.7	838 33.	405 15.9	769 30.3	957 37.7	1300 51.2	553 21.8	307 12.1	719 28.3	788 31.	614 24.2	682 26.9	614 24.2	878 34.6	538 21.2	537 21.1
35	19.3	51.6 113.7	1583 62.3	834 32.8	403 15.9	764 30.1	951 37.4	1293 50.9	551 21.7	305 12	714 28.1	783 30.8	609 24.	676 26.6	609 24.	870 34.3	533 21.	531 20.9
30	19.1	50.7 111.8	1574 62.	831 32.7	400 15.7	759 29.9	944 37.2	1286 50.6	549 21.6	303 11.9	709 27.9	778 30.6	604 23.8	671 26.4	604 23.8	862 33.9	528 20.8	526 20.7
25	18.11	49.8 109.8	1565 61.6	826 32.5	397 15.6	753 29.6	937 36.9	1279 50.4	547 21.5	302 11.9	704 27.7	772 30.4	600 23.6	665 26.2	598 23.5	854 33.6	522 20.6	521 20.5
20	18.8	48.8 107.6	1556 61.3	822 32.4	394 15.5	746 29.4	930 36.6	1271 50.	545 21.5	300 11.8	698 27.5	[illegible]	594 23.4	660 26.	593 23.3	845 33.3	516 20.3	514 20.2
15	18.4	47.7 105.1	1546 60.9	816 32.1	391 15.4	739 29.1	921 36.3	1262 49.7	543 21.4	297 11.7	691 27.2	[illegible] 29.8	585 23.1	652 25.7	585 23.1	836 32.9	508 20.	506 19.9
10	18.1	46.1 101.5	1532 60.3	808 31.8	386 15.2	730 28.7	910 35.8	1250 49.1	540 21.3	293 11.5	683 26.9	748 29.4	580 22.8	642 25.3	578 22.8	823 32.4	498 19.6	496 19.5
5	17.7	44.1 97.3	1512 59.5	797 31.4	380 15.	717 28.2	895 35.2	1231 48.5	[illegible] 21.	289 11.4	669 26.3	733 28.9	568 22.4	627 24.7	566 22.3	804 31.7	479 18.9	478 18.8
2.5	17.5	42.3 93.2	1493 58.8	787 31	373 14.7	706 27.8	882 34.7	1215 47.8	530 20.9	284 11.2	658 25.9	721 28.4	559 22.	613 24.1	551 21.8	789 31.1	465 18.3	465 18.3
1	17	40. 88.2	1471 57.9	775 30.5	365 14.4	694 27.3	868 34.2	1198 47.2	525 20.7	281 11.1	646 25.4	706 27.8	547 21.5	602 23.7	541 21.3	771 30.3	454 17.9	453 17.8

PER CENT.	GIRTH: Knee R.	Knee L.	Calf R.	Calf L.	Ankle R.	Ankle L.	Instep R.	Instep L.	Up.arm R.	Up.arm L.	Elbow R.	Elbow L.	Forearm R.	Forearm L.	Wrist R.	Wrist L.	DEPTH: Chest.	Abdomen.
1	421 16.6	416 16.4	396 15.6	394 15.5	236 9.3	237 9.3	246 9.7	243 9.6	327 12.9	321 12.6	259 10.2	256 10.1	256 10.1	254 10.	170 6.7	169 6.7	214 8.4	228 9.
2.5	407 16.	402 15.8	386 15.2	383 15.1	230 9.1	230 9.1	240 9.4	239 9.4	315 12.4	309 12.2	254 10.	250 9.8	249 9.8	248 9.8	169 6.7	168 6.6	206 8.1	217 8.5
5	396 15.6	392 15.4	377 14.8	375 14.8	227 8.9	227 8.9	237 9.3	235 9.3	300 12.	300 11.8	249 9.8	247 9.7	245 9.6	242 9.5	166 6.5	164 6.5	199 7.9	207 8.1
10	384 15.1	381 15.	367 14.5	366 14.4	222 8.7	224 8.8	231 9.1	230 9.1	296 11.7	290 11.4	245 9.6	240 9.4	239 9.4	237 9.3	162 6.4	160 6.3	193 7.6	197 7.8
15	377 14.8	375 14.8	362 14.3	361 14.2	219 8.6	219 8.6	229 9.	228 9.	290 11.4	285 11.2	240 9.4	238 9.4	235 9.3	233 9.2	160 6.3	159 6.3	187 7.4	191 7.5
20	372 14.6	370 14.6	358 14.1	357 14.1	217 8.5	217 8.5	227 8.9	226 8.9	286 11.3	281 11.1	238 9.4	236 9.3	232 9.1	229 9.	159 6.3	158 6.2	187 7.4	188 7.4
25	368 14.5	366 14.4	354 13.9	353 13.9	214 8.4	215 8.5	225 8.9	224 8.8	282 11.1	277 10.9	236 9.3	234 9.2	229 9.	227 8.9	157 6.2	157 6.1	185 7.3	185 7.3
30	364 14.3	361 14.2	351 13.8	350 13.8	212 8.3	213 8.4	224 8.8	222 8.7	279 11.	274 10.8	234 9.2	231 9.1	226 8.9	224 8.8	157 6.2	155 6.1	182 7.2	182 7.2
35	362 14.2	358 14.1	347 13.7	346 13.6	210 8.3	211 8.3	222 8.7	220 8.7	270 10.9	271 10.7	232 9.1	229 9.	224 8.8	222 8.7	156 6.1	154 6.1	180 7.1	179 7.
40	357 14.1	355 14.	344 13.5	343 13.5	209 8.2	209 8.2	220 8.7	219 8.6	274 10.8	268 10.6	230 9.1	228 9.	222 8.7	220 8.7	155 6.1	153 6.	179 7.	177 7.
45	354 13.9	352 13.9	341 13.4	340 13.4	207 8.1	208 8.2	219 8.6	218 8.6	271 10.7	266 10.5	229 9.	226 8.9	220 8.7	218 8.6	154 6.1	152 6.	177 7.	175 6.9
50	351 13.8	349 13.7	338 13.3	337 13.3	205 8.1	206 8.1	217 8.5	216 8.5	269 10.6	264 10.4	227 8.9	225 8.9	218 8.6	216 8.5	153 6.	151 5.9	175 6.9	173 6.8
45	348 13.7	346 13.6	335 13.2	334 13.1	204 8.	205 8.1	216 8.5	215 8.5	266 10.5	261 10.3	226 8.9	223 8.8	216 8.5	214 8.4	152 6.	150 5.9	174 6.9	171 6.7
40	345 13.6	344 13.5	333 13.1	332 13.1	203 8.	203 8.	215 8.5	214 8.4	263 10.4	259 10.2	224 8.8	222 8.7	214 8.4	212 8.3	151 5.9	149 5.9	172 6.8	169 6.7
35	342 13.5	341 13.4	330 13.	329 13.	201 7.9	202 8	213 8.4	212 8.3	261 10.3	256 10.1	223 8.8	220 8.7	212 8.3	210 8.3	149 5.9	148 5.8	171 6.7	167 6.6
30	339 13.4	338 13.3	327 12.9	326 12.8	200 7.9	200 7.9	212 8.3	211 8.3	258 10.2	253 10.	221 8.7	218 8.6	211 8.3	207 8.1	148 5.8	146 5.7	169 6.7	164 6.5
25	336 13.2	335 13.2	323 12.7	323 12.7	198 7.8	198 7.8	211 8.3	210 8.3	255 10.	251 9.9	219 8.6	216 8.5	207 8.1	205 8.1	147 5.8	145 5.7	167 6.6	162 6.4
20	332 13.1	332 13.1	320 12.6	320 12.6	195 7.7	196 7.7	209 8.2	207 8.1	252 10.	247 9.7	217 8.5	214 8.4	204 8.	202 8.	145 5.7	144 5.7	164 6.5	160 6.3
15	329 13.	328 12.9	310 12.4	315 12.4	193 7.6	193 7.6	206 8.1	205 8.1	248 9.8	243 9.6	214 8.4	212 8.3	201 7.9	200 7.9	144 5.7	143 5.6	162 6.4	157 6.2
10	324 12.8	322 12.7	311 12.2	310 12.2	191 7.5	191 7.5	204 8.	203 8.	243 9.6	238 9.4	212 8.3	210 8.3	197 7.8	195 7.7	142 5.6	141 5.6	160 6.3	153 6.
5	317 12.5	315 12.4	302 11.9	302 11.9	185 7.3	185 7.3	201 7.9	200 7.9	235 9.3	231 9.1	207 8.1	203 8.	191 7.5	191 7.5	141 5.6	140 5.5	154 6.1	150 5.9
2.5	312 12.3	311 12.2	295 11.6	295 11.6	182 7.2	182 7.2	197 7.8	195 7.7	230 9.1	224 8.8	203 8.	202 8	185 7.3	185 7.3	138 5.4	135 5.3	151 5.9	145 5.7
1	305 12.	303 11.9	289 11.4	287 11.3	178 7.	178 7.	193 7.6	192 7.6	221 8.7	218 8.6	200 7.9	195 7.8	182 7.2	181 7.1	133 5.2	132 5.2	145 5.7	140 5.5

PER CENT.	BREADTH: Head.	Neck.	Shoulders.	Waist.	Hips.	Nipples.	LENGTH: Shoulder Elbow R.	Shoulder Elbow L.	Elbow Tip R.	Elbow Tip L.	Foot R.	Foot L.	Stretch of Arms.	STRENGTH: Back.	Legs.	Chest.	Forearm R.	Forearm L.	Capacity of Lungs.
1	168 6.6	119 4.6	404 15.9	261 10.3	383 15.1	239 9.3	377 14.8	378 14.9	460 18.3	460 18.1	265 10.4	264 10.4	1761 69.3	101 222.6	170 374.7	40 88.2	38 83.8	35 77.1	3.45 211.
2.5	165 6.5	116 4.5	398 15.7	254 10.	370 14.6	243 9.6	371 14.6	370 14.6	459 18.1	457 18.	259 10.2	259 10.2	1740 68.7	95 209.4	155 341.6	38 83.8	36 79.3	33 72.7	3.25 200.6
5	160 6.3	112 4.4	391 15.4	248 9.8	363 14.3	238 9.4	366 14.4	366 14.4	455 17.9	452 17.8	257 10.1	256 10.1	1726 68.	90 198.4	146 321.8	36 79.3	35 77.1	31 68.3	3.12 190.7
10	159 6.3	109 4.3	386 15.2	242 9.5	354 13.9	231 9.1	360 14.2	360 14.2	448 17.6	446 17.6	251 9.9	250 9.8	1706 67.2	81 178.5	135 297.5	33 72.7	33 72.7	29 63.9	2.96 180.6
15	155 6.2	104 4.3	380 15.	239 9.4	348 13.7	227 8.9	357 14.1	356 14.	444 17.5	442 17.4	249 9.8	248 9.8	1689 66.5	77 169.7	124 273.3	32 70.5	31 68.3	28 61.7	2.82 172.3
20	157 6.2	108 4.3	378 14.9	236 9.3	344 13.5	222 8.7	354 13.9	353 13.9	440 17.3	438 17.2	247 9.7	247 9.7	1677 66.	74 163.1	117 257.9	31 68.3	30 66.1	27 59.5	2.79 170.2
25	157 6.2	107 4.2	375 14.8	233 9.2	340 13.4	218 8.6	351 13.8	350 13.8	437 17.2	435 17.1	246 9.7	245 9.6	1666 65.6	71 156.5	111 244.6	30 66.1	29 63.9	26 57.3	2.71 165.7
30	156 6.1	106 4.2	372 14.6	230 9.1	337 13.3	216 8.5	348 13.7	348 13.7	434 17.1	432 17.	244 9.6	243 9.6	1657 65.2	69 152.1	105 231.4	29 63.9	29 63.9	25 55.1	2.63 160.8
35	155 6.1	105 4.1	370 14.6	228 9.	333 13.1	214 8.4	346 13.6	346 13.6	432 17.	429 16.9	242 9.5	242 9.5	1649 64.9	66 145.5	101 222.6	28 61.7	28 61.7	24 52.9	2.61 159.8
40	154 6.1	104 4.1	368 14.5	226 8.9	330 13.	212 8.3	344 13.5	344 13.5	429 16.9	427 16.8	241 9.5	240 9.4	1639 64.5	63 138.9	98 216.	28 61.7	27 59.5	24 52.9	2.53 154.7
45	153 6.	104 4.1	365 14.4	224 8.8	327 12.9	209 8.2	342 13.5	342 13.5	427 16.8	425 16.7	239 9.4	239 9.4	1630 64.2	61 134.4	95 209.4	27 59.5	26 57.3	23 50.7	2.47 150.8
50	152 6.	103 4.	364 14.3	222 8.7	324 12.8	207 8.1	340 13.4	340 13.4	425 16.7	423 16.7	238 9.4	237 9.3	1621 63.8	59 130.	91 200.6	26 57.3	26 57.3	22 48.5	2.40 150.3
45	151 5.9	102 4.	362 14.3	220 8.7	321 12.6	205 8.1	338 13.3	338 13.3	422 16.6	421 16.5	237 9.3	236 9.3	1611 63.4	56 123.4	88 194.	25 55.1	25 55.1	21 46.3	2.40 146.5
40	151 5.9	101 4.	360 14.2	217 8.5	318 12.5	203 8.	336 13.2	336 13.2	420 16.5	418 16.4	235 9.3	235 9.3	1604 63.1	54 119.	83 183.	25 55.1	25 55.1	21 46.3	2.32 142.
35	150 5.9	100 3.9	358 14.1	215 8.5	314 12.4	201 7.9	334 13.1	333 13.1	418 16.4	416 16.3	234 9.2	233 9.2	1596 62.8	51 112.4	81 178.5	24 52.9	24 52.9	20 44.1	2.30 140.4
30	148 5.8	99 3.9	355 14.	213 8.4	311 12.2	198 7.8	332 13.1	331 13.	415 16.3	413 16.2	232 9.1	232 9.1	1589 62.6	50 110.2	77 169.7	23 50.7	23 50.7	20 44.1	2.22 135.8
25	147 5.8	97 3.8	353 13.9	210 8.3	307 12.1	196 7.7	330 13.	329 13.	412 16.2	411 16.1	231 9.1	230 9.1	1580 62.2	47 103.6	75 165.3	22 48.5	22 48.5	19 41.9	2.14 130.8
20	145 5.7	95 3.7	350 13.8	207 8.1	302 11.9	193 7.6	327 12.9	326 12.8	410 16.1	407 16.	229 9.	228 9.	1569 61.8	43 94.8	71 156.5	21 46.3	21 46.3	18 39.7	2.13 130.1
15	144 5.7	93 3.7	346 13.6	203 8.	297 11.7	190 7.5	321 12.5	323 12.7	406 15.9	404 15.9	227 8.9	226 8.9	1556 61.3	40 88.2	67 147.7	19 41.9	20 44.1	17 37.5	1.98 120.9
10	142 5.6	91 3.6	342 13.5	198 7.8	291 11.4	185 7.3	321 12.6	320 12.6	402 15.8	400 15.7	224 8.8	223 8.8	1543 60.7	36 79.3	61 134.4	17 37.5	19 41.9	16 35.3	1.90 115.9
5	141 5.6	88 3.5	336 13.2	191 7.5	282 11.1	179 7.	313 12.3	313 12.3	395 15.6	393 15.5	221 8.7	221 8.7	1517 59.7	30 66.1	55 121.2	15 33.1	17 37.5	15 33.1	1.78 109.
2.5	140 5.5	84 3.3	332 13.1	185 7.3	274 10.8	171 6.9	308 12.1	307 12.1	391 15.4	389 15.4	216 8.5	216 8.5	1491 58.7	25 55.1	50 110.2	14 30.9	15 33.1	14 30.9	1.62 99.
1	136 5.4	82 3.2	320 12.8	181 7.1	268 10.6	170 6.7	302 11.9	302 11.9	382 15.1	381 15.1	212 8.3	211 8.3	1460 57.5	20 44.1	41 90.4	12 26.4	14 30.9	11 24.2	1.32 80.7

FIG. 46.

PER CENT.	AGE.	WEIGHT.	HEIGHT. Height.	HEIGHT. Sitting.	HEIGHT. Knee.	HEIGHT. Pubes.	HEIGHT. Navel.	HEIGHT. Sternum.	GIRTH. Head.	GIRTH. Neck.	GIRTH. Chest.	GIRTH. Chest full.	GIRTH. Ninth rib.	GIRTH. Ninth rib full.	GIRTH. Waist.	GIRTH. Hips.
1	31.6	21. 156.5	1710 67.3	914 36.	476 18.8	867 34.1	1050 41.3	1420 55.9	584 23.	346 13.6	879 34.6	913 35.9	815 32.1	859 33.8	739 29.1	1058 41.6
2.8	27.11	67.6 148.8	1709 67.	899 35.4	468 18.4	848 33.4	1044 41.1	1399 55.1	579 22.8	339 13.3	847 33.3	892 35.1	782 30.8	829 32.6	709 27.9	1038 40.8
6	26.	64.2 141.5	1685 66.3	889 35.	458 18.	833 32.8	1030 40.5	1378 54.3	574 22.6	333 13.1	834 32.8	878 34.5	764 30.1	808 31.8	690 27.2	1018 40.1
10	24.	60.6 133.9	1665 65.5	876 34.5	449 17.7	816 32.1	1016 40.	1364 53.7	569 22.4	327 12.9	815 32.1	859 33.8	743 29.2	783 30.6	670 26.4	989 38.9
15	23.	58.5 128.9	1649 64.9	869 34.2	443 17.4	806 31.7	1002 39.4	1349 53.1	564 22.2	319 12.5	804 31.6	849 33.4	731 28.8	772 30.4	659 25.9	969 38.1
20	22.	57.0 125.6	1638 64.5	865 34.	439 17.3	798 31.4	994 39.1	1339 52.7	560 22.	318 12.5	798 31.4	839 33.	720 28.3	764 30.1	649 25.5	955 37.6
25	21.4	55.6 123.	1629 64.1	860 33.9	433 17.	790 31.1	987 38.8	1330 52.4	559 22.	315 12.4	789 31.1	832 32.7	710 27.9	709 29.9	643 25.3	941 37.
30	20.10	54.6 120.1	1621 63.8	857 33.7	429 16.9	783 30.8	979 38.5	1324 52.1	558 21.9	312 12.3	779 30.7	829 32.6	708 27.8	750 29.5	636 25.	933 36.7
35	20.6	53.6 117.9	1614 63.5	853 33.6	426 16.8	778 30.6	973 38.3	1318 51.9	555 21.8	309 12.2	778 30.6	819 32.2	699 27.5	744 29.3	629 24.7	924 36.4
40	20.	52.7 116.1	1605 63.1	848 33.4	422 16.6	772 30.4	968 38.1	1310 51.6	553 21.7	309 12.2	769 30.3	818 32.2	698 27.5	739 29.1	624 24.6	916 36.1
45	19.10	51.9 114.4	1598 62.9	844 33.2	419 16.5	765 30.1	960 37.8	1304 51.3	550 21.6	308 12.1	765 30.1	809 31.8	689 27.1	730 28.7	619 24.4	909 35.8
50	19.3	51. 112.4	1590 62.6	840 33.1	416 16.4	760 29.9	956 37.6	1298 51.1	549 21.6	304 12.	759 29.9	804 31.6	685 27.	728 28.6	613 24.1	899 35.4
45	19.	50. 110.2	1584 62.4	838 33.	413 16.3	756 29.8	950 37.4	1290 50.8	546 21.5	302 11.9	753 29.6	799 31.4	679 26.7	719 28.3	609 24.	894 35.2
40	18.9	49.1 108.2	1576 62.	834 32.8	409 16.1	750 29.5	947 37.2	1284 50.5	545 21.4	299 11.8	749 29.5	793 31.2	673 26.5	718 28.2	605 23.8	888 34.9
35	18.6	48.1 106.	1568 61.7	829 32.6	406 16.	745 29.3	940 37.	1279 50.3	543 21.4	299 11.8	742 29.2	789 31.1	669 26.3	709 27.9	600 23.6	879 34.6
30	18.1	47.3 104.3	1560 61.4	825 32.5	404 15.9	739 29.1	934 36.8	1273 50.1	540 21.3	298 11.7	739 29.1	780 30.7	660 26.	709 27.8	594 23.4	869 34.2
25	17.11	46.5 102.5	1553 61.1	819 32.2	399 15.7	734 28.9	928 36.5	1265 49.8	539 21.2	294 11.6	730 28.7	778 30.6	659 25.9	699 27.5	589 23.2	859 33.8
20	17.6	45.6 100.3	1543 60.7	815 32.1	396 15.6	728 28.7	919 36.2	1258 49.5	538 21.1	290 11.4	728 28.6	789 30.9	650 25.6	696 27.4	583 22.9	849 33.4
15	17.	44.3 97.7	1529 60.2	810 31.9	392 15.4	720 28.3	912 35.9	1248 49.1	534 21.	288 11.4	719 28.3	765 30.1	646 25.4	689 27.1	578 22.7	838 33.
10	16.6	42.9 94.6	1516 59.6	805 31.7	388 15.3	711 28.	899 35.4	1236 48.6	529 20.8	288 11.3	709 27.9	758 29.8	633 24.9	678 26.7	568 22.4	819 32.2
5	15.9	40.5 89.2	1499 59.	795 31.2	378 14.9	697 27.4	884 34.8	1210 47.6	524 20.6	280 11.	698 27.5	739 29.1	619 24.4	659 25.9	558 22.	788 31.
2.8	15.	39.4 86.8	1478 58.2	783 30.8	371 14.6	684 26.9	869 34.2	1204 47.4	519 20.4	279 10.9	685 26.9	726 28.6	609 23.9	649 25.5	543 21.4	778 30.6
1	14.1	35.6 78.9	1453 57.2	765 30.1	360 14.2	662 26.2	847 33.3	1184 46.6	513 20.2	274 10.6	665 26.2	709 27.9	596 23.4	636 25.	527 20.7	756 29.6

PER CENT.	AGE.	GIRTH. Thigh R.	Thigh L.	Knee R.	Knee L.	Calf R.	Calf L.	Ankle R.	Ankle L.	Instep R.	Instep L.	Up. arm R.	Up. arm L.	Elbow R.	Elbow L.	Forearm R.	Forearm L.	Wrist R.	Wrist L.
1	31.6	655 25.8	649 25.5	418 16.4	414 16.3	380 15.	380 15.	223 8.7	234 9.2	240 9.4	239 9.4	318 12.5	310 12.2	249 9.8	248 9.8	258 10.1	258 10.1	166 6.6	154 6.4
2.8	27.11	629 24.8	624 24.6	404 15.9	396 15.5	371 14.6	370 14.6	228 9.	229 9.	238 9.4	233 9.2	306 12.	299 11.6	243 9.6	241 9.5	255 10.	250 9.8	161 6.3	160 6.3
6	26.	612 24.1	610 24.	390 15.3	389 15.3	366 14.4	364 14.3	222 8.7	220 8.7	230 9.	228 9.	294 11.6	288 11.3	239 9.4	238 9.4	249 9.8	245 9.6	159 6.2	158 6.2
10	24.	600 23.6	590 23.2	379 14.9	376 14.9	353 13.9	353 13.9	216 8.6	216 8.6	226 8.9	224 8.8	283 11.1	279 10.9	239 9.2	229 9.	244 9.6	239 9.4	155 6.1	154 6.1
15	23.	580 22.8	580 22.8	370 14.6	369 14.5	349 13.7	349 13.7	211 8.3	211 8.3	223 8.8	221 8.7	279 11.	273 10.7	229 9.	228 9.	240 9.4	237 9.3	154 6.	153 6.
20	22.	570 22.4	569 22.4	364 14.3	361 14.2	343 13.5	342 13.5	209 8.2	208 8.2	220 8.6	219 8.6	273 10.7	269 10.6	228 8.9	224 8.8	238 9.2	233 9.2	152 6.	150 6.
25	21.4	563 22.2	560 22.	359 14.1	358 14.1	339 13.3	339 13.3	208 8.2	208 8.2	219 8.6	216 8.6	269 10.6	264 10.4	224 8.8	221 8.7	235 9.2	230 9.	150 5.9	149 5.9
30	20.10	560 21.9	554 21.8	357 14.	354 13.9	336 13.2	334 13.1	207 8.1	206 8.1	218 8.6	215 8.5	265 10.4	260 10.2	222 8.7	219 8.6	233 9.2	229 9.	149 5.9	149 5.9
35	20.6	549 21.6	548 21.6	352 13.9	350 13.8	330 13.	330 13.	204 8.	204 8.	215 8.5	214 8.4	261 10.3	258 10.1	220 8.6	218 8.6	230 9.1	227 8.9	149 5.9	148 5.8
40	20.	544 21.4	540 21.3	349 13.7	348 13.7	329 12.9	328 12.9	202 7.9	202 7.9	214 8.4	213 8.4	259 10.2	254 10.	219 8.6	217 8.5	229 9.	224 8.8	148 5.8	148 5.8
45	19.10	539 21.2	538 21.2	348 13.7	344 13.5	325 12.8	324 12.7	200 7.9	200 7.9	212 8.3	210 8.3	258 10.1	250 9.8	216 8.5	214 8.4	228 8.9	223 8.6	148 5.8	146 5.7
50	19.3	534 21.	531 20.9	342 13.5	340 13.4	323 12.7	321 12.6	199 7.8	199 7.8	210 8.3	209 8.2	253 9.9	248 9.7	215 8.5	213 8.4	225 8.8	220 8.6	147 5.8	145 5.7
45	19.	529 20.8	528 20.8	330 13.3	330 13.3	319 12.5	319 12.5	198 7.6	198 7.8	209 8.2	208 8.2	249 9.8	245 9.6	214 8.4	210 8.3	223 8.8	219 8.6	145 5.7	144 5.6
40	18.9	524 20.6	519 20.4	338 13.2	334 13.1	318 12.5	316 12.5	198 7.7	197 7.7	208 8.2	208 8.2	248 9.7	240 9.4	212 8.3	209 8.2	221 8.7	216 8.5	144 5.7	143 5.6
35	18.6	518 20.4	514 20.2	331 13.	330 13.	314 12.4	313 12.3	194 7.6	194 7.6	208 8.2	206 8.1	244 9.6	238 9.4	210 8.2	209 8.2	219 8.6	216 8.5	144 5.6	143 5.6
30	18.1	510 20.1	509 20.	329 12.9	328 12.9	310 12.2	309 12.2	193 7.6	193 7.6	204 8.	204 8.	240 9.4	237 9.3	209 8.2	208 8.1	219 8.6	214 8.4	143 5.6	141 5.5
25	17.11	504 19.8	500 19.7	325 12.8	324 12.7	308 12.1	308 12.1	190 7.6	190 7.5	203 8.	203 8.	239 9.4	233 9.2	208 8.1	206 8.1	218 8.5	211 8.3	141 5.6	140 5.5
20	17.6	498 19.6	494 19.4	320 12.6	320 12.6	306 11.9	304 11.9	189 7.4	189 7.4	201 7.9	201 7.9	234 9.2	229 9.	206 8.	203 8.	214 8.4	208 8.2	140 5.5	139 5.5
15	17.	489 19.2	488 19.2	318 12.5	316 12.5	298 11.8	299 11.6	188 7.4	188 7.4	199 7.8	199 7.8	229 9.	226 8.9	203 8.	200 7.9	211 8.3	206 8.1	139 5.5	138 5.4
10	16.6	479 18.8	476 18.8	310 12.2	310 12.2	294 11.6	294 11.6	185 7.3	185 7.3	198 7.8	198 7.8	226 8.9	219 8.6	199 7.8	198 7.8	209 8.2	204 8.	138 5.4	137 5.4
5	15.9	464 18.3	459 18.1	306 12.	304 11.9	284 11.2	284 11.2	180 7.1	181 7.1	194 7.6	193 7.6	219 8.6	213 8.4	198 7.8	194 7.6	204 8.	199 7.8	134 5.3	134 5.3
2.8	15.	447 17.6	446 17.5	298 11.7	298 11.7	279 11.	279 11.	178 7.	178 7.	189 7.4	189 7.4	210 8.3	207 8.1	193 7.6	189 7.4	200 7.9	196 7.7	133 5.2	131 5.2
1	14.1	429 16.8	428 16.8	293 11.5	290 11.4	269 10.6	269 10.6	174 6.8	174 6.8	188 7.4	188 7.4	201 7.9	199 7.8	189 7.4	188 7.4	196 7.7	191 7.5	130 5.1	129 5.2

PER CENT.	AGE.	DEPTH. Chest.	DEPTH. Abdomen.	BREADTH. Head.	BREADTH. Neck.	BREADTH. Shoulders.	BREADTH. Waist.	BREADTH. Hips.	BREADTH. Nipples.	LENGTH. Shoulder Elbow R.	LENGTH. Shoulder Elbow L.	LENGTH. Elbow Tip R.	LENGTH. Elbow Tip L.	LENGTH. Foot R.	LENGTH. Foot L.	LENGTH. Stretch of Arms.	STRENGTH. Back.	STRENGTH. Legs.	STRENGTH. Chest.	STRENGTH. Forearm R.	STRENGTH. Forearm L.	Capacity of Lungs.
1	31.6	190 7.6	210 8.3	157 6.2	104 4.1	404 15.9	252 9.9	385 15.1	242 9.5	379 14.9	374 14.7	468 18.4	468 18.4	258 10.1	258 10.1	1760 69.3	99.6 219.6	154.6 340.6	38.6 84.9	33.6 74.1	31.3 69.	3.7 226.1
2.8	27.11	193 7.6	198 7.8	155 6.1	101 4.	397 15.6	244 9.6	370 14.6	228 9.	372 14.6	367 14.4	458 18.	458 18.	258 10.	252 9.9	1735 68.3	94.8 209.	139.6 308.2	35.3 77.8	31.4 69.4	29.2 64.4	3.4 207.7
6	26.	188 7.4	189 7.4	153 6.	100 3.9	391 15.4	239 9.4	363 14.3	219 8.6	366 14.4	363 14.3	453 17.8	450 17.7	248 9.8	249 9.8	1717 67.6	88.8 195.7	132.9 293.	32.6 71.9	29.5 65.	27.2 60.	3.24 197.7
10	24.	183 7.2	180 7.1	151 5.9	98 3.9	384 15.1	233 9.2	352 13.8	210 8.3	358 14.1	357 14.	445 17.5	444 17.5	246 9.7	244 9.6	1690 66.5	79.6 175.5	121.2 267.2	29.8 65.7	27.0 59.5	26. 57.3	3. 182.2
15	23.	179 7.	176 6.9	150 5.9	97 3.8	379 14.9	229 9.	346 13.6	207 8.1	356 14.	353 13.9	440 17.3	439 17.3	244 9.6	242 9.5	1674 65.7	75.8 167.1	109.6 241.6	28.2 62.2	26.6 58.4	24.4 53.8	2.88 175.6
20	22.	170 6.9	170 6.7	149 5.8	95 3.7	370 14.5	226 8.9	340 13.4	203 8.	352 13.8	349 13.7	437 17.2	435 17.1	240 9.4	240 9.4	1660 65.3	70.8 156.1	104.4 230.2	26.7 58.9	25.9 57.1	23.3 51.4	2.75 167.6
25	21.4	174 6.8	169 6.6	148 5.8	94 3.7	373 14.7	224 8.8	337 13.3	199 7.8	349 13.7	347 13.6	434 17.1	432 17.	239 9.4	239 9.4	1649 64.9	67.9 149.7	96.9 213.6	25.5 56.2	24.8 54.7	22. 48.5	2.66 161.8
30	20.10	172 6.7	166 6.5	147 5.8	94 3.7	370 14.6	221 8.7	333 13.1	196 7.7	347 13.6	344 13.5	431 17.	429 16.9	237 9.3	237 9.3	1639 64.5	65.4 144.2	92.8 204.6	24.6 54.	23.9 52.7	21.6 47.6	2.58 157.5
35	20.6	169 6.6	164 6.4	146 5.7	93 3.6	369 14.5	219 8.6	330 13.	193 7.6	344 13.5	342 13.5	429 16.9	427 16.8	236 9.3	235 9.2	1629 64.1	60.1 132.5	89.1 196.4	23.6 52.	23.2 51.1	21.2 46.7	2.52 153.6
40	20.	168 6.6	161 6.3	145 5.7	92 3.6	366 14.4	218 8.6	328 12.9	190 7.5	343 13.5	339 13.3	427 16.8	425 16.7	234 9.2	234 9.2	1620 63.8	58.7 129.3	82.1 181.	22.6 49.6	22.3 49.2	20.7 45.6	2.44 146.6
45	19.10	166 6.5	159 6.2	145 5.7	91 3.6	364 14.3	216 8.5	325 12.8	189 7.4	340 13.4	338 13.3	424 16.7	423 16.6	233 9.2	233 9.2	1610 63.4	56.4 124.3	79.3 174.8	21.7 47.8	21.7 47.8	19.9 43.9	2.40 146.3
50	19.3	164 6.4	157 6.2	144 5.6	90 3.5	362 14.2	214 8.4	322 12.7	187 7.3	338 13.3	335 13.2	421 16.6	420 16.5	232 9.1	223 9.1	1604 63.1	54. 119.	76.6 168.6	20.9 46.1	21.4 47.2	19.3 42.7	2.31 141.2
45	19.	163 6.4	154 6.1	144 5.6	89 3.5	359 14.1	212 8.3	319 12.6	184 7.2	336 13.2	333 13.1	419 16.5	418 16.4	231 9.1	230 9.	1597 62.9	49.8 109.8	70.6 155.4	20. 44.1	21. 46.3	18.6 41.	2.26 137.3
40	18.9	160 6.3	153 6.	143 5.6	89 3.5	358 14.1	209 8.2	317 12.5	183 7.2	334 13.1	331 13.	417 16.4	416 16.4	229 9.	229 9.	1589 62.5	48.2 106.3	66.7 147.	19.4 42.8	20. 44.1	17.6 39.2	2.71 135.1
35	18.6	159 6.2	150 5.9	142 5.6	88 3.5	355 14.	208 8.2	314 12.4	179 7.	331 13.	329 12.9	415 16.3	413 16.3	228 9.	228 9.	1579 62.2	46.7 102.9	64.1 141.3	18.5 40.8	19.2 42.3	16.9 37.2	2.12 129.6
30	18.1	158 6.2	149 5.6	141 5.5	88 3.4	353 13.9	207 8.1	311 12.2	176 7.	329 12.9	327 12.9	412 16.2	411 16.2	227 8.9	226 8.9	1570 61.8	45.2 99.6	61. 134.5	17.3 38.1	18.4 40.6	16.6 36.4	2.07 126.5
25	17.11	156 6.1	148 5.8	140 5.5	87 3.4	350 13.6	204 8.	308 12.1	175 6.9	327 12.9	326 12.8	409 16.1	409 16.1	226 8.8	225 8.8	1561 61.4	40.7 89.7	54.2 119.5	16.3 35.9	17.6 38.6	16.1 35.5	1.98 120.9
20	17.6	154 6.1	146 5.7	139 5.5	86 3.4	348 13.7	202 7.9	304 12.	172 6.8	324 12.7	322 12.7	407 16.	405 15.9	224 8.6	223 8.8	1549 61.	38. 83.8	51.2 112.9	15.4 33.9	16.7 36.8	15.3 33.7	1.9 116.6
15	17.	150 5.9	143 5.6	138 5.4	84 3.3	344 13.6	199 7.8	300 11.8	169 6.6	320 12.6	319 12.5	404 15.9	403 15.8	221 8.7	221 8.7	1539 60.6	35.7 78.7	48.3 106.5	14.4 31.7	16.2 35.7	14.3 31.5	1.78 108.9
10	16.6	148 5.8	140 5.5	136 5.3	83 3.3	339 13.3	198 7.7	297 11.7	165 6.5	317 12.5	315 12.4	399 15.7	398 15.6	219 8.6	218 8.6	1520 59.8	30.6 67.2	40. 88.2	13.2 29.1	14.8 32.6	13.1 28.9	1.67 101.9
5	15.9	144 5.7	136 5.3	132 5.2	81 3.2	332 13.1	190 7.5	288 11.3	159 6.2	310 12.2	309 12.1	393 15.5	390 15.3	215 8.5	216 8.5	1494 58.8	25.6 56.4	33.5 73.8	11.2 24.7	12.7 28.	11.6 25.6	1.49 99.7
2.8	15.	139 5.5	133 5.2	129 5.1	79 3.1	326 12.6	188 7.4	279 11.	158 6.	306 12.	304 12.	386 15.2	384 15.1	213 8.4	212 8.3	1475 58.1	23.2 51.1	25.6 56.9	9.7 21.4	11.4 25.1	11. 24.2	1.29 76.1
1	14.1	136 5.3	129 5.1	126 5.	78 3.1	316 12.5	183 7.2	268 10.6	149 5.9	300 11.8	297 11.7	380 15.	379 14.9	207 8.1	207 8.1	1451 57.1	15.9 35.	21. 46.3	8.3 18.	10.6 23.1	9.6 21.2	1.07 65.4

FIG. 47.

has been popularly attributed to the Yankee. A comparison of these tables suggests a possible influence of environment in producing a racial or local type, for in general, the ancestry of the Ohio pupil is the same as that of the Wellesley pupil. It is possible also that the early occupations of these students have differed so widely, as also their food supply, as to produce the modifications noticed. It should also be borne in mind that the personal equation or method in taking the records is marked in the results seen.

In 1893 Dr. Hitchcock of Amherst issued a table made up of a determination of averages on the basis of heights; that is, he grouped the records of 1,322 students between the ages of seventeen and twenty-six years, according to the height of the individuals, separating the groups according to a gradation of one centimeter. His records varied from 160 to 183 centimeters. He found the average for each one of these groups and arranged them as seen in Fig. 48.

The nearest approximation to the general college average is found to be the grade representing the averages of men from 172 to 173 centimeters in height. It may be said that this table gives us the best standard of the various dimensions that are characteristic of American young men between the ages of seventeen and twenty-six. The arrangement of the figures in the squares is the same as that used in the percentile table. This table cannot be used for graphic illustration so successfully as can the percentile table, although for men of nearly the mean dimensions the table is satisfactory for this purpose. In the use of this table it is believed that a method suggested by Dr. Kellogg in a chart (see Fig. 49) issued in 1895 could be used to advantage, for it combines a high value for graphic purposes, with the reliable standard afforded by an arithmetical mean determined

Stature	Weights	Heights: Sternum	Heights: Navel	Heights: Pubes	Heights: Knee	Heights: Sitting	Girths: Head	Girths: Neck	Girths: Chest Repose	Girths: Chest Full	Girths: Belly	Girths: Hips	Girths: Right Thigh	Girths: Left Thigh	Girths: Right Knee	Girths: Left Knee	Girths: Right Calf	Girths: Left Calf	Girths: Right Instep	Girths: Left Instep	Girths: Upper Right Arm Contracted	Girths: Upper Right Arm	Girths: Upper Left Arm	Girths: Right Elbow	Girths: Left Elbow	Girths: Right Forearm	Girths: Left Forearm	Girths: Right Wrist	Girths: Left Wrist	Breadths: Head	Breadths: Neck	Breadths: Shoulders	Breadths: Nipples	Breadths: Waist	Breadths: Hips	Lengths: Right Shoulder Elbow	Lengths: Left Shoulder Elbow	Lengths: Right Elbow Tip	Lengths: Left Elbow Tip	Lengths: Right Foot	Lengths: Left Foot	Lengths: Stretch of Arms	Lengths: Horizontal Length	Strength: Lungs	Strength: Back	Strength: Dip	Strength: Pull	Strength: Legs	Strength: Right Forearm	Strength: Left Forearm	Strength: Total	Capacity of Lungs	Pilosity
1600 mm. 63.0 in.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1610 mm. 63.4 in.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1620 mm. 63.8 in.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1630 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1640 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1650 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1660 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1670 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1680 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1690 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1700 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1710 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
College Average [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1730 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1740 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1750 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1760 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1770 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1780 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1790 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1800 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1810 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1820 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1830 mm. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

FIG. 48.

PHYSICAL CHART

Classified and Arranged According to Heights from 64 to 72 Inches.

Arranged from the results obtained in testing the strength of the individual groups of muscles in 1500 MEN, by means of the Universal Dynamometer. The figures given represent the mean-average for each group of muscles respectively. Made and compiled under the direction of J. H. KELLOGG, M. D., Superintendent of the Sanitarium and Hospital, Battle Creek, Mich.

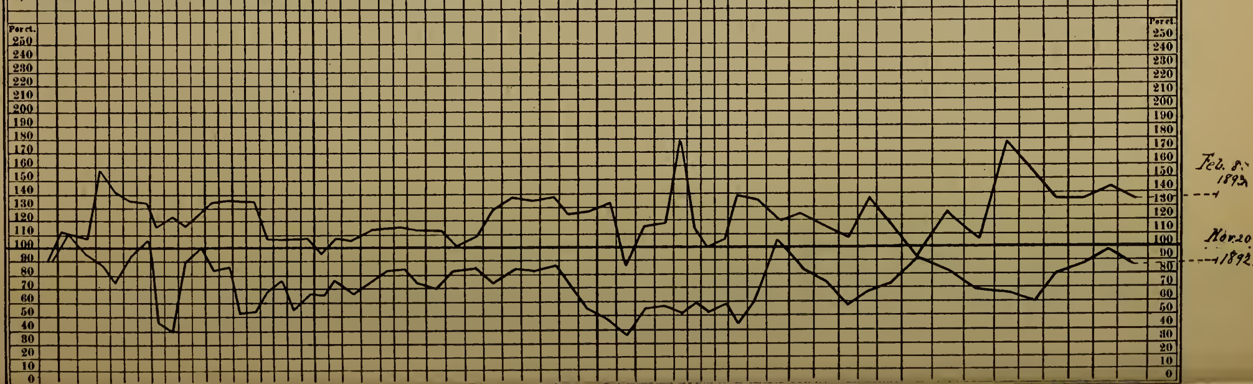
Except when Otherwise Indicated, Quantities are Expressed in Pounds Avoirdupois.

HEIGHT (inches). / Date.	WEIGHT.	ARMS. R. Hand Flexors.	L. Hand Flexors.	R. Hand Extensors.	L. Hand Extensors.	R. Forearm Pronators.	L. Forearm Pronators.	R. Forearm Supinators.	L. Forearm Supinators.	R. Arm Flexors.	L. Arm Flexors.	R. Arm Extensors.	L. Arm Extensors.	R. Deltoid.	L. Deltoid.	R. Pectoral.	L. Pectoral.	R. Shoulder Retractor.	L. Shoulder Retractor.
72	151	129	121	42	37	72	68	62	62	59	61	50	57	69	69	92	96	82	85
71	150	127	123	35	35	65	63	64	61	55	56	57	58	65	60	92	93	79	77
70	141	118	115	35	34	66	64	63	60	58	58	66	56	66	63	86	88	75	75
69	140	111	109	34	32	60	58	57	54	55	54	55	56	63	63	87	85	74	75
68	134	113	109	33	37	61	59	59	55	55	52	55	55	61	61	83	83	74	74
67	133	111	107	31	30	59	57	58	55	54	53	56	59	62	62	86	86	78	79
66	126	98	94	31	28	58	55	55	53	52	52	51	52	63	62	86	85	72	73
65	126	103	100	33	33	58	55	55	55	57	52	52	52	63	61	83	81	71	71
64	115	93	88	30	30	49	43	45	43	49	51	48	47	55	53	71	71	63	67
11/20/92	135	140	120	30	25	60	65	30	25	50	55	50	50	55	35	60	70	45	50
2/8/93	135	140	130	55	50	90	85	75	75	65	70	75	80	90	90	105	105	85	85

HEIGHT (inches). / Date.	LEGS. R. Foot Flexors.	L. Foot Flexors.	R. Foot Extensors.	L. Foot Extensors.	R. Leg Flexors.	L. Leg Flexors.	R. Leg Extensors.	L. Leg Extensors.	R. Thigh Flexors.	L. Thigh Flexors.	R. Thigh Extensors.	L. Thigh Extensors.	R. Thigh Abductors.	L. Thigh Abductors.	R. Thigh Adductors.	L. Thigh Adductors.
72	71	70	271	268	92	88	115	120	131	135	156	155	102	101	111	103
71	73	67	294	268	90	88	108	107	130	131	163	148	96	93	105	104
70	67	65	260	244	80	83	104	101	122	120	140	139	92	90	104	100
69	68	68	248	244	82	83	101	103	124	126	130	138	91	90	97	98
68	67	67	247	248	84	81	101	101	129	126	139	138	93	90	94	98
67	66	65	240	239	82	81	100	99	121	122	138	134	92	91	99	99
66	61	60	249	240	79	80	100	98	117	121	134	134	88	88	97	97
65	62	61	230	224	78	78	97	94	115	115	134	138	85	85	93	93
64	56	56	200	188	69	65	81	84	98	99	110	108	72	74	76	79
11/20/92	50	50	200	190	72	75	80	75	105	115	120	120	85	80	80	77
2/8/93	70	70	300	300	100	100	120	120	130	140	200	200	130	130	130	135

HEIGHT (inches). / Date.	TRUNK. Trunk Anterior.	Trunk Posterior.	Trunk R. Lateral.	Trunk L. Lateral.	Neck Anterior.	Neck Posterior.	Neck R. Lateral.	Neck L. Lateral.	RESPIRATION. Inspiration, Diaphragm.	Inspiration — Chest.	Spirometer (litres).	TOTAL STRENGTH. ARMS.	LEGS.	TRUNK.	CHEST.	ENTIRE BODY.
72	118	278	122	115	37	64	54	56	146	160	4.70	1319	2094	844	306	4563
71	123	297	131	126	31	65	56	51	146	169	4.46	1271	2064	903	315	4553
70	117	271	115	113	22	64	53	53	141	158	4.20	1246	1912	808	299	4265
69	117	292	117	117	32	68	52	53	134	154	4.16	1182	1900	848	290	4220
68	112	286	114	116	32	62	51	51	128	107	4.07	1179	1903	824	297	4203
67	116	302	117	114	32	61	53	54	134	157	4.00	1181	1868	849	285	4183
66	111	271	114	110	30	59	49	49	114	141	3.77	1120	1843	703	255	4011
65	110	270	118	109	31	59	51	50	118	141	3.74	1133	1782	788	259	3962
64	96	241	96	99	29	53	42	45	109	124	3.36	998	1515	701	233	3445
11/20/92	70	140	85	85	20	45	35	35	75	120	4.67	1062	1514	515	195	3346
2/8/93	160	250	150	150	75	75	65	65	200	220	5.40	1580	2370	950	420	5295

HEIGHT (inches). / Date.	COEFFICIENTS. Height-Weight.	Strength - Weight.	Strength - Height.	Respiratory - Weight.	Respiratory - Height.	Vital - Efficiency.	Vital - Development.	Arms-Strength - Weight.	Legs - Strength - Weight.	HEIGHT (inches).
72	38.13	30.22	1.236	9.50	.389	.314	.316	8.73	13.87	72
71	38.39	30.35	1.250	9.40	.386	.310	.321	8.05	13.76	71
70	36.62	30.25	1.187	8.90	.350	.293	.295	8.83	13.56	70
69	36.89	30.14	1.192	8.56	.339	.284	.286	8.43	13.57	69
68	35.82	31.14	1.205	8.64	.344	.278	.285	8.80	14.20	68
67	36.09	31.45	1.217	8.50	.332	.271	.273	8.89	14 05	67
66	34.71	31.83	1.185	7.70	.284	.241	.239	8.89	14.63	66
65	35.24	31.44	1.188	7.70	.290	.244	.243	8.99	14.14	65
64	32.67	29.96	1.049	6.81	.237	.229	.226	8.66	13.18	64
11/20/92	34.02	24.78	.859	6.22	.235	.251	.274	7.86	11.65	70.8
2/8/93	34.02	39.22	1.359	16.83	.587	.428	.431	11.48	17.55	70.8



for men on the basis of their varying height. The fallacy of the supposition that a percentile grade represented a standard for an individual, as claimed by some, has been pointed out by Dr. Gulick, Dr. Boas and others. Here, however, we have the standard determined by mathematical treatment of the records of persons of the same height, and the person may then be graphically represented in the same way that he could be represented on a percentile chart made up from the measurements of persons of his own height. This introduces a new and important feature into graphic anthropometry, and one table becomes available for representing any individual within the limits of the tabulation.

"It is a recognized law that the strength increases in proportion to the square of the height, whereas height increases in simple arithmetical ratio. In order to furnish a basis for a more just comparison two charts have been prepared upon the basis of height, including such heights as fall within the limits of 58 and 67 inches for women and 63 to 72 inches for men. Provision is made for a graphic percentage representation in the diagram occupying the lower half of the chart, upon which per cents may be written at any level from 0 to 250. To obtain the percentage relation of the person examined to the mean-average person of the same height, it is only necessary to divide the number found for each individual group of muscles by the number shown in the proper columns for the mean-average person of the given height. Having found the percentage in this manner, a dot is made with a pencil in the proper column, and at a level corresponding with the percentage shown by the quotient obtained. If the quotient is 1, the dot will be made opposite, or in line with 100, and the meaning is that the strength of the group of muscles tested is equal to that of the mean-average person of the same height.

If the amount obtained by dividing the number found by the number representing the strength of the same group of muscles in the average person of the same height is less than 1, as .50 for example, this represents that the strength of the group of muscles examined is only one-half, or 50 per cent, that of the mean-average person of the same height. A dot is accordingly located opposite to, or in line with, the number 50 in the per cent column. In like manner, points may be located for each group of muscles. Connecting the points by lines, we have a graphic representation in which the relation of the individual examined to the mean-average person of the same height is accurately shown (Fig. 49). All the points in the chart which fall below 100 indicate relative inferiority of strength; all the points above the 100-line represent relative superiority in strength."

In considering these percentile tables taken from the records of college students it is well to bear in mind several points. First that the percentile table does not furnish us a working type or model of proportions in its fifty per cent line, but it is rather a statement of the actual physical size of the college community at the time these records were gathered. Very few of the records entering into the compilation represent physical maturity, although this is more nearly true of the tables for women than for men. It is a notorious fact that a large percentage of college students have received no adequate physical training or exercise before reaching college. Their lives have been abnormal and unnatural in that, during the playing period of their lives, they have been closely confined to a line of mental processes that dealt largely with abstract subjects and that deprived them of physical activity. As a result of this method of life muscular sizes must be abnormally small in the great majority

of cases, and a table constructed from such measurements will show a man that is truly "mean." To determine so far as possible the variation of the fifty per cent line on the table of Yale measurement from what might be expected in a similar table constructed from the measurements of men of a like age but who had taken a large amount of physical exercise, and who could be considered in perfect health, I selected five hundred individuals from two thousand and grouped their measurements according to the percentile method. The results are shown by the lines representing the twenty-five per cent grades, as well as the mean, that are plotted on the regular table as shown in Fig. 43. It is believed that this new fifty per cent line represents a much more reliable standard of physical excellence than the line representing the mean of the whole college community.

A glance at these lines shows us several facts: First —That the relation between bone size and muscle size varies in different types of men, viz., in the short person the muscles have a much larger proportional size than in the tall person. This has been demonstrated before in other ways and formulated into a law that the working power of a muscle varies as its cubical contents. Second—That there is a direct ratio between exercise and bone growth. The lengths of leg in all these cases plot higher than length of trunk. Third—A high development seems to declare itself in more increase of depths than of breadths. Fourth—That there is a direct ratio between size of muscles and capacity of lungs. Fifth—That girth of waist increases with chest and hips but not in the same proportion. Sixth—That high nutrition power is essential to high development. Seventh—That muscular and nervous strength increases in greater proportion than other items; so we may infer that high strength tests indicate physical welfare. Eighth—That

exercise gives a measurable increase in stamina and tends to produce a distinguishable type of man.

Dr. Enebuske has developed into a new form the more important indices as a basis for graphic use in showing the physical condition of a person (Fig. 50). In this graphic diagram Dr. Enebuske presents a curve, *a*, representing an individual who was too weak to be admitted to class work in the school; curve *b* representing the weakest student who was admitted to the normal class of the school; curve *c* representing the average working capacity of 1,100 female students of Wellesley College, from data furnished by Miss M. A. Wood of Wellesley; curve *d* on the chart shows the average of the students entering the school before the beginning of their gymnastic training; curve *e* shows the average of forty-two graduates of the school of an average age of twenty-three years; curve *f* represents a record of a student whose working capacity corresponded most closely to the average working capacity of the graduates; curve *g* represents the highest record made by all female students up to the date of the paper; curve *h* represents the average Amherst student; curve *i* represents a male student of the Normal School of Gymnastics; curve *j* represents a Yale student of the 50 per cent grade. This curve represents also the average of fifty naval cadets of the U. S. N. Curve *k* represents the record of a male student of the Normal School of Gymnastics, as does also the curve *l*. This form of chart is used in the Boston Normal School of Gymnastics as a test of the physical condition of the students, who are examined monthly, and if the curve at any time falls below what may be expected from the previous record the conditions of work are examined, and so far as possible errors of method are corrected, or, failing to find such errors, the pupil is relieved of part or all of the work until a physi-

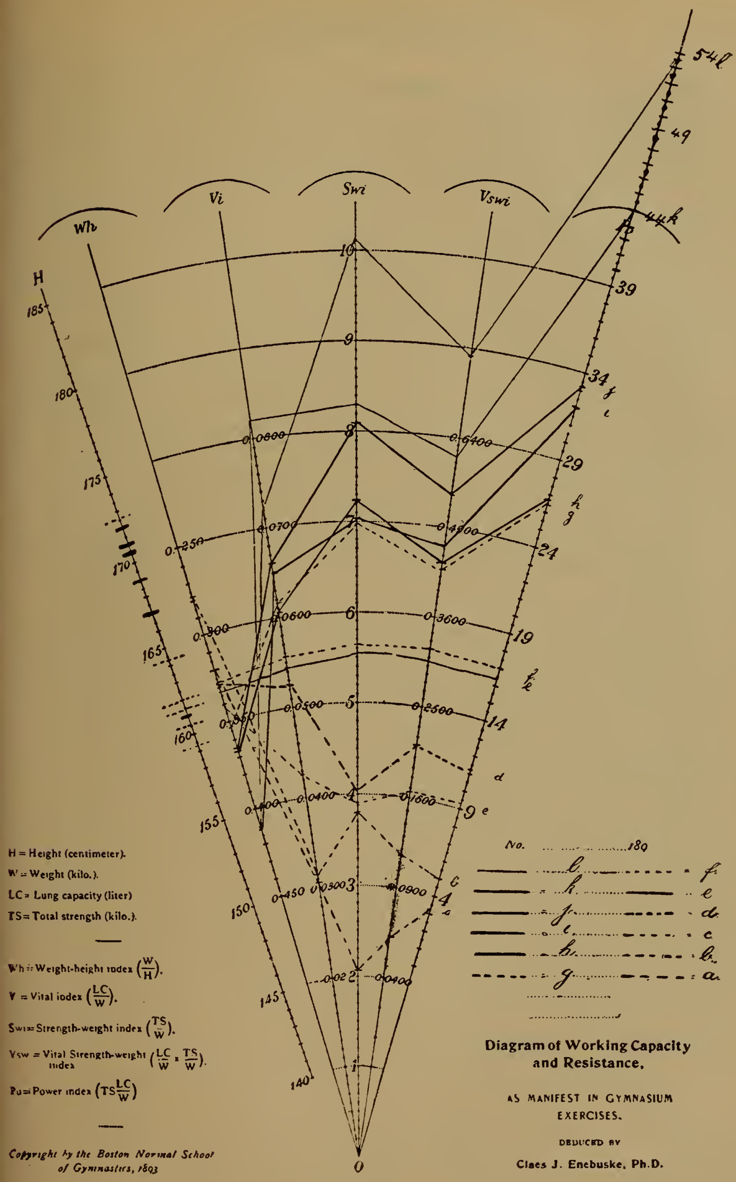

H
Wh
Vi
Swi
Vswi
H = Height (centimeter).
W = Weight (kilo.).
LC = Lung capacity (liter)
TS = Total strength (kilo.).
Wh = Weight-height index $\left(\frac{W}{H}\right)$.
V = Vital index $\left(\frac{LC}{W}\right)$.
Swi = Strength-weight index $\left(\frac{TS}{W}\right)$.
Vsw = Vital Strength-weight index $\left(\frac{LC}{W} \times \frac{TS}{W}\right)$.
Pu = Power index $\left(TS\frac{LC}{W}\right)$
Copyright by the Boston Normal School of Gymnastics, 1893
No. 189
Diagram of Working Capacity and Resistance,
AS MANIFEST IN GYMNASIUM EXERCISES.
DEDUCED BY
Claes J. Enebuske, Ph.D.

FIG. 5C.

ological condition is reached that will bear the severe work of the school.

With the invention of the Kellogg dynamometer and the consequent ability to test more accurately special groups of muscles, we have put at our disposal a means of extending the study of ratios between the size of various parts and their working ability, and this ratio may obviously be expressed in the form of an index or coëfficient; and thus it is believed that the graphic chart of the future that is to give an individual a clear conception of his standing as a member of the community must show him his relation to others, not only in size but in working capacity. And a closer study of method will give us coëfficients that shall also indicate the quality of work, as well as its quantity. Not until this point is reached can anthropometry be said to have fulfilled its mission.

In connection with the arrangement of the percentile charts of strength tests there has been a study of the relation of strength to weight and to height, and for the mean, the strength weight index, as determined by Dr. Kellogg, is 37.34 for men and 23.42 for women. This index as determined by Dr. Enebuske is 7.5 for men and 5 for women. The difference being due to the larger number of tests used by the former. The ratio is essentially the same. thus establishing the comprehensive character of the ratio. The relation between weight and lung capacity is probably more definite than the relation between height and lung capacity, because weight is a definite statement of the amount of tissue to be supplied with oxygen, while height relates simply to the arrangement of the mass, rather than to its amount.

The statement that for each increase in height of 25 mm. we should expect an increase in weight of one kilogram relates only to the general proportions existing

among men, whereas the average weight of a transverse section of 25 mm. would undoubtedly be greater than this amount. But respiration is physiologically a measure of the cellular activity of the body, rather than of the number of its cells, and therefore we should expect those cells that undergo rapid metabolism, and that consequently tax the respiratory function for both the supply of oxygen and the elimination of their carbonic oxide, to bear a closer relation to lung capacity than would total weight. Muscular tissue stands at the head of all cellular structure in the vigor and continuity of its activity, glandular structure being the only tissue that compares with it in the violence of its metabolism. But glandular activity is periodical and fairly uniform among all persons, the processes being primary and vital, while muscular activity is secondary and voluntary. It would seem, then, that muscular size must be the measure of lung capacity. Now strength is the expression of muscular size and activity (*i. e.*, nerve stimulation), and therefore the relation between strength and lung capacity must be a definite and measureable one.

The relation between strength and height cannot be direct, although some coëfficient may be determined that shall express it with a fair degree of accuracy; but the mere expression of height, without relation to weight or girth records, tells nothing of the muscular size, and, as we have seen, this and its related nerve influence is the determining factor of strength. That tall people are on the average stronger than short people does not refute the argument already stated, because in general tall people are also heavier and larger in girth than short people, and consequently their muscle mass must be larger.

The relation between strength and girth would seem to give us a coëfficient that would be fairly reliable and

constant, especially if we include in the girths only the girths of the limbs. The reason for this exclusion will be obvious if we consider for a moment the fact that limb development cannot be secured without a simultaneous development of the muscles of the trunk, as the muscles of the limbs are directly connected with the trunk, and any phase of their activity is accompanied by a responsive contraction of some group of muscles to steady the trunk for the support of the force that is to be exerted by the movement of the limb—the trunk being a fulcrum, as it were, for the lever constituted by the limb. Yet the trunk girths may be large from accumulated adipose tissue and the limb girths be comparatively small, owing to habits of inactivity and scant muscular exercise. In other words, we may have large trunk girths and poor limb girths, but not the reverse. The limb girths, then, are a fair measure of the muscular activity of the individual, and consequently may be truly said to bear a definite relation to the strength of the individual. It has been noted as an anthropological fact that in the more highly developed races of men the increased size and development of the legs is a characteristic feature.

If we consider a ratio of height to weight we have an indication of the excess of storage tissue or of the scant development of the soft tissues and therefore have a coëfficient that must bear a fairly close relation to strength. This relationship could be expressed by another line on the chart of Dr. Enebuske and wide divergence from the normal lead of anticipation of poor condition of work.

A breadth-strength coëfficient, or a depth-strength coëfficient, would apparently be unreliable for the same reasons that operate against a strength-height coëfficient. That is, we may have breadth representing a possibility for muscular attachments, and still these mus-

cles may not be properly developed, while in the case of depths, the large upper trunk depth would indicate an approximation to the round type of chest, which is primitive and not compatible with large lung capacity; while large depth of the lower trunk is indicative of muscular weakness or insufficient oxidative power. On the other hand, small depth of chest may be coincident with excessively poor muscular development or with a fair degree of muscular development and large respiratory power. It would seem, then, that neither of these measurements could be depended upon as a basis for determining coëfficients.

In 1889 Dr. W. L. Savage devised a chart for use in plotting the measures of boys and youths. The scheme is very ingenious and will be found generally useful when the table on which it is based is placed in the hands of instructors. The chart can be used for any age and gives absolute record of averages rather than comparative. These averages are computed for all ages from one to twenty years and arranged in concentric circles.

In 1890 the most completely graphic method that has yet been devised was completed by Dr. E. Hitchcock, Jr. It is based on the tabulation of 15,000 sets of measurements—all made by physicians who were experienced in the work. The figure is drawn from the average of the various measures, and lines to right and left show in a perfect manner the relation of girths as they are actually found to exist. The relation in size of limb girths to semi-girths of the trunk have never been so clearly demonstrated before, and therefore the chart is an important contribution to artistic anatomy.

The numerical method of comparison has been the one in most general use because the data necessary for making a graphic picture of a person's anatomical proportions has only recently been made public. The advantage of

a graphic illustration of physical proportions is as great as the advantage of that method in any department of scientific work. It discloses at a glance what is discovered only after considerable time spent in study of figures. It would seem that the union of the graphic and numerical methods of stating the proportions of an individual must be more comprehensive than either method alone, and more satisfactory to both instructor and student.

The use of photography is a legitimate application of graphic principles and it will soon be employed in all gymnasiums where scientific study and accurate work is accomplished. It gives an idea of the form of a man that cannot be derived from figures or graphic lines, and will therefore show results of exercise that figures cannot express.

CHAPTER VIII.

THE LAW OF GROWTH.

The presentation of the law of growth has been accomplished in various ways. The underlying principle, however, in most of these methods, depends upon the approximation of any group of measurements to the binomial curve, as first demonstrated by Quetelet. The measurements may be grouped into symmetrical grades according to the percentile form, or they may be grouped into gradations or series according to some common unit, as, for instance, the weights may be grouped according to the grades representing kilogram or other variations from birth to maturity, and heights may be graded by using the centimeter, etc., as the unit, and all the measurements graded from the shortest number at birth to the highest number found at maturity. This latter method has been followed by Dr. Beyer in his comprehensive brochure on the growth of the United States naval cadets, where he also combines it with the percentile method. Records may also be grouped according to their relation to some particular part that may be taken as a unit or modulus for the other measurements. This method has recently been followed by Dr. W. S. Hall in a paper* on "The Changes in the Proportions of the Human Body During the Period of Growth," where he considers the total height of the body as the modulus, and gives the sizes of the other parts in fractions of the total height. This method also may be combined with the percentile method, as shown by Dr. Hall. The

---

* *Journal of the Anthropological Institute of Great Britain and Ireland.* Aug., 1895.

scientific value of this latter method depends on the proportional contrasts that it presents between parts at various stages of growth, as it has long ago been proved that there is no fixed relation between the proportions of the various parts of the body. Finally we may have the method of arithmetical means or averages. This method is applicable to a wide range of investigation and gives us a result which is essentially the same as the fifty per cent line in the "percentile" method, and the mean in the method of "probabilities" and the "most frequent value," if the material considered is homogeneous.

As shown by Quetelet the method of averages can be applied to material that is small in amount and that is not uniform, while the method of means can only be applied to uniform material. The material represented by a group of men in an American college cannot be considered homogeneous and for this reason certain men like Dr. Hitchcock of Amherst have preferred to use the average methods in tabulating their data. A selection of material according to ages in these groups of college statistics is still open to the objection that the individuals represent mixed racial types, and consequently the curve showing the frequency of occurrence of values will not conform to a true binomial type. It has been shown by Gould in his report of the sanitary commission that the men from certain regions, notably Tennessee, Kentucky and Indiana, are of taller type than were found in other sections, notably New York, New Jersey and Pennsylvania. Obviously a college that contained a large number of students from any one of these localities would have the height curve seriously modified, and the height of most frequent occurrence might be changed without changing the average appreciably. The average height of students in the various colleges illustrates

the fact that there is a difference in type in different parts of our country. This may be seen by reference to the percentile charts of Wellesley and Oberlin women (Figs. 46 and 47.), and by Fig. 51, showing the height

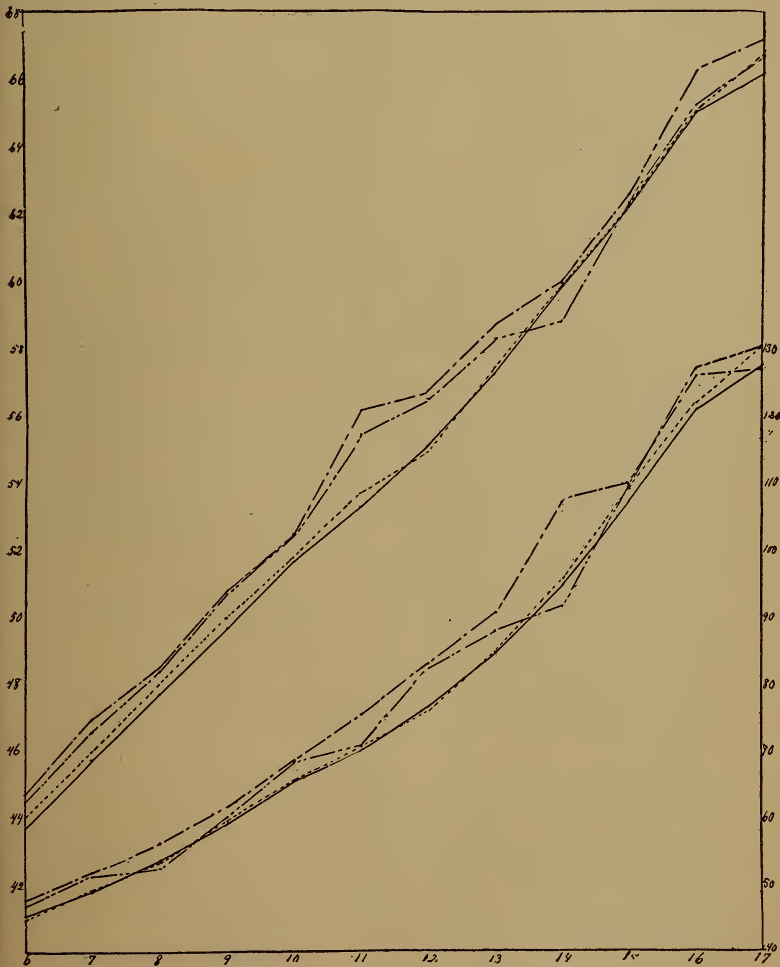


FIG. 51.

and weight of boys. The upper group of lines represent heights and the lower weights. The solid line is from Bowditch; the dotted line Peckham; the dot and dash Gilbert, while the two dots and dash show the median values for New Haven boys.

When, however, the measurements are arranged in percentile grades as suggested by Galton, while the 50 per cent line does not have the authority of the average, it is not the only feature of the compilation. This fifty per cent line as before stated is found to be essentially the same as the average, where the group considered is homogeneous, and in addition to the determination of this value we know how all the records are distributed. As, for instance, we may say that one per cent of all the records in any given item were as large as the number found in the corresponding grade at top of the table, or as small as the number in the grade at the bottom of the chart. It also enables us to trace the variation in the group and discover by the departure from the binomial curve the presence of any material that is not homogeneous. It being assumed and fairly well demonstrated that there is a mean around which all human proportions are grouped in symmetrical forms.

The so-called binomial curve depends for its determination upon the coëfficients of a binomial quantity, as $x + y$ raised to any given power. The numerical value of the coëfficients may be represented by lines, Fig. 51, and if these lines be arranged parallel to each other on a common base and a line drawn connecting the tops of the adjacent lines, we shall have an approximation to a curve, and this approximation will be rendered more complete the higher the power to which the binomial quantity is raised. For instance, if we raise $x + y$ to the tenth power, we shall have for coëfficients 1, 10, 45, 120, 210, 252, 210, 120, 45, 10, 1. The middle line is the

mean around which the others are grouped in symmetrical order. This form of distribution is found in the arrangement by chance of all quantities of similar objects. For instance, if an equal number of black and white balls be placed in a box, thoroughly mixed, and

FIG. 52.

drawn by chance, in groups of ten, 1024 times, which is the sum of the preceding coëfficients, it will be found that once all ten balls will be black, once all will be white and the various coëfficients in the expanded binomial will represent the number of times that the balls would be drawn in the relative proportion of black and white that is indicated by the relation of the exponents of the two quantities in each term of the expanded binomial. The sizes of men in the community who have a common ancestry and a common environment tend to group themselves in exactly this same order about a common type or mean.

If now we group any number of measurements of a dimension, as of height, weight, etc., in order from the smallest up to the largest, dividing them into as many equal divisions of size as our expanded binomial has terms, we shall find that the numbers in these groups are represented graphically by the height of the lines,

as in Fig. 52. It is obvious to any one that instead of dividing into these eleven arbitrary divisions we might divide them into twenty divisions or a hundred, according to the gradations of size. If one hundred were made the basis of the division we should then have the records grouped according to percentages, as was suggested by Galton. This grouping has been found the most convenient that has yet been discovered, for it determines not only the mean, which in any uniform data will be the same as the average or arithmetical mean, but it determines the mathematical relation of any point in the curve to the mass of material represented by the balance of the curve.

Dr. Boas has called attention in a paper published in the report of the American Statistical Association, 1893, to some of the causes that prevent the distribution of physical measurements according to the strict law of chance. He mentions the failure in the uniformity of ancestral type with a multiplicity of type in the offspring represented by the data; in other words, there is a lack of homogeneity in the data to be tabulated. He also mentions the lack of uniformity in growth at the various periods, and such material must evidently be considered by some calculus of variables rather than by the simple binomial law. He prefers the method of mean variation for statistical purposes. In the percentile grade system of tabulation we have certain misleading features that should be noted by all persons who make use of it for graphic purposes. For instance it is often assumed that the line of any percentile grade represents an individual or what an individual ought to be. This fallacy results from the association together of data that have no relation to each other. Each column of figures being arranged solely with relation to one dimension. If, for instance, we consider the column representing total

height, and then compare with it two other columns which bear a tabular relation to it that is constant, namely, the height sitting and the height of pubis, which gives the length of legs, we would find that if the measurement of any individual be applied to this percentile chart and the total height fall upon the thirty per cent line we would have no right to assume that the height sitting would fall upon the same grade, for it may fall on the fifty per cent grade or on the ten per cent, etc., the total height, being made up essentially of the two records considered, may be the sum of one short and one long element so that if the height sitting fell upon a higher grade than the total height the length of legs would fall upon a lower grade and vice versâ. In fact, the probability of the two height elements falling on one grade is strongly against its occurrence.

The interrelation of other proportions may be even less distinct than the case mentioned. In studying the growth of different individuals, it would seem that a general law of growth cannot apply to all cases; and that even the application of a law determined for any type as suggested by Dr. Porter, has wide limitations, for the relation between the bone growth and muscular growth of tall boys is not the same as between the bone and the muscle growth of short boys. In the period of accelerated growth from twelve to fifteen years of age the increase of bone lengths is markedly greater than the increase in muscular tissue* (this will be seen by reference to the tables of Dr. Bowditch, Dr. Porter and others, if we assume that weight is a fair index of the growth of the muscular parts), while the period from six-

* This observation has been formulated by Dr. W. S. Hall as follows: "When the vertical dimension of the body is undergoing an acceleration of its rate of growth the horizontal dimensions undergo a retardation of their rate of growth, and conversely."

teen to twenty-three is a period of comparatively slow bone growth and of rapid muscular growth, just as in the decennial period from forty to fifty the marked increase in weight must be attributed to storage tissue rather than to either bone or muscle growth. It would seem to be important then that some investigation should be made to classify the data according to the general type of individual that they represent, and from this classified data determine anew the law of growth.

It should also be borne in mind that the rapidity of growth varies in the different sections of the country, apparently according to climatic and telluric conditions. Another factor to be considered in the study of anthropometric data is the personal equation that is characterstic of each individual when working with more or less plastic material. This will be especially noticeable in the records of girths and breadths, where slight variation in tension occasions a wide divergence in records. Attention should also be given to the important matter of having a record of all of the group in order to make the records reliable for tabulation purposes. If, for instance, a percentile chart be arranged from the measurements of such students as offer themselves for examination in a college where the examination is optional with the students the grades will not conform with any fair degree of regularity to the binomial curve, because in general two sets of men will offer themselves for examination. First the athletic group of men who are well developed and are proud of the physical record that they can make, and who may wish suggestion as to further improvement. The second group will be made up of physical wrecks who find themselves unable to do the college work without much physical hardship and who are in hopes of receiving such hygienic suggestions as shall enable them to continue their work. Between

these two groups will come a few men who more truly represent the ordinary student and whose influence on the chart should be the dominating one. If, then, we are to tabulate by the generalizing method we must have a large mass of material that shall have been gathered in such a way as to have the errors and the omissions of one group balanced by the data supplied by another group, and in the final tabulation it will probably be found necessary to treat the resulting curve mathematically in order to establish the true values for any given grades. When, however, the whole of any group is measured, and by one person, a comparatively small number of persons will be found to exhibit the type and the general distribution of the records for all such persons. Thus it is found that a percentile table made from the records of five hundred college men of the same age (within the limits of one year) that includes all the men of that age in college at one time, will represent a closer approximation to the binomial curve than will the record of 2,500 men of similar ages gathered from year to year under the optional system of physical examination.

In studying the law of growth attention is called to the chart prepared by Schuyler B. Moon of McDonogh, Md., as shown in Fig. 53. This table is made by grouping the measurements of one hundred and fifteen boys between the ages of thirteen and fourteen years according to Galton's percentile method. The 50 per cent column represents what we may call the mean, and for the sake of comparison the 50 per cent lines from four other charts, prepared by the same author, are graphically represented on this one. The first line beginning at the left represents the mean of boys between eleven and twelve years of age. We notice that the items of height and length, the two being similar dimensions, diverge farther

ANTHROPOMETRIC TABLE.

McDONOGH SCHOOL, McDONOGH, MARYLAND.

Compiled from the Measurements of 115 Boys between the Ages of 13 and 14 years.
By SCHUYLER B. MOON.

Arranged according to the Percentages indicated at the top. Units: Years, Kilograms, Millimetres, and Litres.

PER CENT	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
AGE	13.1	13.1	13.1	13.2	13.2	13.3	13.3	13.3	13.3	13.5	13.5	13.6	13.6	13.7	13.8	13.8	13.8	13.8	13.9
WEIGHT	27.9	29.2	29.8	30.3	31.4	31.7	32.6	33.2	33.6	34.0	34.8	35.3	35.8	36.4	37.6	37.7	40.8	43.0	46.5
HEIGHT	1334	1367	1382	1385	1391	1398	1405	1415	1428	1437	1445	1450	1461	1466	1475	1496	1505	1537	1570
Knee	[illegible]	357	364	368	373	[illegible]	380	382	383	387	390	393	393	397	399	401	406	413	[illegible]
Sitting	693	706	710	713	717	722	727	732	734	740	744	748	752	759	[illegible]	775	785	795	806
Pubic Arch	659	679	686	691	696	698	704	712	715	721	725	732	737	740	746	750	756	767	791
Navel	799	815	826	832	840	842	843	852	861	867	873	877	882	886	892	899	905	923	943
Sternum	1077	1104	1110	1114	1121	1125	1132	1140	1150	1161	1168	1176	1178	1186	1192	1204	1214	1246	[illegible]
GIRTH																			
Head	512	515	518	523	526	528	530	531	[illegible]	535	536	537	540	541	542	543	547	552	563
Neck	261	264	267	270	271	273	273	275	277	279	280	280	282	284	[illegible]	290	293	299	309
Chest repose	644	657	666	[illegible]	676	689	692	696	702	707	710	713	722	726	739	749	755	770	802
Chest full	681	692	700	715	720	727	730	735	738	741	745	752	757	768	776	786	795	803	841
9th Rib repose	588	602	609	617	623	629	635	635	643	646	650	655	662	665	674	682	685	704	718
9th Rib full	641	654	661	672	678	684	690	698	702	704	709	713	719	723	734	743	759	767	780
Waist	558	364	569	575	580	591	598	602	608	614	616	621	625	631	636	644	657	669	686
Hips	648	659	672	678	686	690	694	702	707	716	721	726	728	734	742	[illegible]	766	770	807
R. Thigh	364	372	378	383	391	394	396	400	404	406	410	411	416	422	427	432	440	450	459
L. Thigh	364	370	377	382	388	391	396	399	400	406	409	411	416	419	423	430	438	451	458
R. Knee	273	279	281	285	289	290	294	295	300	300	302	305	308	313	315	318	322	331	340
L. Knee	273	278	280	286	288	293	296	297	299	301	303	305	308	312	317	321	326	331	335
R. Calf	253	257	262	266	270	274	276	280	281	281	284	287	288	292	295	301	307	311	326
L. Calf	254	257	261	267	271	274	275	277	281	283	285	287	290	293	296	303	307	315	328
R. Ankle	169	173	176	180	183	185	186	187	189	190	190	192	195	196	198	204	209	212	218
L. Ankle	172	177	180	182	183	184	185	187	190	191	192	195	198	200	202	204	210	215	220
R. Instep	193	195	197	198	200	202	203	205	206	207	208	210	214	216	218	220	226	229	232
L. Instep	190	193	194	197	198	199	200	201	203	205	205	207	210	213	215	217	220	225	228
R. Upper Arm	196	198	201	205	207	208	210	212	214	216	217	220	222	226	231	234	240	243	253
L. Upper Arm	192	194	198	200	202	205	206	208	209	210	212	215	220	221	224	229	234	437	250
R. Elbow	179	183	185	187	190	192	192	194	195	196	197	199	200	203	205	208	214	218	223
L. Elbow	178	180	182	185	186	187	189	191	192	193	194	195	197	198	203	206	209	213	220
R. Forearm	191	195	196	198	200	201	203	205	206	208	210	211	214	216	219	222	226	231	235
L. Forearm	188	191	193	195	196	198	200	201	203	204	205	206	208	212	214	219	223	225	230
R. Wrist	129	130	131	133	134	135	136	138	139	139	140	141	142	144	145	147	150	154	156
L. Wrist	127	129	130	132	133	133	134	135	137	138	139	140	141	143	144	145	150	151	155
DEPTH:																			
Chest	140	145	149	150	150	153	156	157	158	159	160	162	163	166	169	170	172	176	179
Abdomen	143	145	146	149	152	154	156	159	160	162	163	164	166	167	168	172	174	176	182
BREADTH:																			
Head	140	141	142	144	145	146	146	147	147	148	149	[illegible]	150	150	150	151	152	155	155
Neck	87	88	89	89	90	91	91	92	93	93	94	94	95	96	96	97	98	99	102
Shoulders	314	319	321	326	328	332	333	335	337	339	342	344	345	351	354	356	361	368	377
Waist	196	200	203	204	208	210	213	214	215	218	218	220	221	225	226	228	233	238	241
Hips	236	241	244	247	250	253	254	257	259	261	263	265	266	268	270	274	279	282	[illegible]
Nipples	131	135	138	140	142	143	144	146	147	149	151	154	155	157	159	162	164	169	176
LENGTH																			
R. Should.-Elbow	281	287	290	296	297	300	301	302	305	307	309	311	314	315	317	320	324	329	339
L. Should.-Elbow	278	284	287	291	294	297	299	300	302	304	306	308	311	313	314	319	322	327	338
R. Elbow-Tip	358	365	369	372	376	379	382	385	387	389	391	395	396	399	402	405	411	415	421
L. Elbow-Tip	353	362	367	370	375	377	378	383	385	387	389	392	395	397	399	404	406	413	418
R. Foot	215	220	221	224	225	226	227	228	229	230	231	233	235	237	240	242	244	249	252
L. Foot	214	219	223	224	225	227	227	228	230	232	233	234	236	237	241	244	246	250	252
Horizontal	1338	1378	1388	1390	1399	1403	1414	1422	1436	1446	1450	1460	1470	1475	1484	[illegible]	1509	1543	1574
Stretch	1338	1370	1387	1405	1422	1431	1444	1450	1457	1465	1481	1492	1497	1507	1514	1526	1538	1560	1590
CAPACITY OF LUNGS	1.70	1.74	1.77	1.80	1.90	1.92	2.00	2.00	2 10	2 13	2.17	2.20	2.28	2.35	2.40	2.47	2.58	2.70	2.91
STRENGTH:																			
Lungs	.7	9	1.0	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.5	1.6	1.7
Back	60.0	65.0	70.0	72.0	75.0	76.0	79.3	80.0	80.8	82.0	83.0	84.0	86.0	87.0	89.0	91.0	95.0	98.0	110.0
Legs	91.5	99.5	120.0	125.0	133.8	140.0	146.3	152.0	158.8	165.0	168.5	173.0	179.3	180.5	183.0	186.0	190.8	207.0	213.8
Chest	16.0	17.8	19.0	19.5	20.0	21.0	21.5	22.0	23.0	23.0	24.0	25.0	25.4	26.0	27.0	27.5	28.5	29.0	31.5
Upper Arm	.0	.0	.0	.0	3.0	3.5	5.9	[illegible]	9.7	11.0	13.4	16.7	[illegible]	23.2	25.1	27.7	[illegible]	47.0	70.6
Forearm	12.5	14.5	15.1	15.5	16.0	16.0	16.6	17.0	17.5	18.0	18.8	19.0	19.5	20.0	[illegible]	21.5	22.2	[illegible]	25.6
Total	194.8	217.0	231.1	242.8	254.8	[illegible]	286.4	292.6	301.5	312.0	316.0	320.3	324.5	332.4	336.8	345.8	352.9	375.5	[illegible]

FIG. 53.

from the 50 per cent line of this chart than do the girth or breadth measurements, which shows a tendency in the growth of boys to increase in girth proportions more rapidly in early life than they do in length proportions, while at a later period the reverse is true—the lengths increase more rapidly than girths. This demonstrates fully the law that while girth measurements are accelerated length measurements are retarded, and vice versâ.

The next point to which attention is called is the large girth of head, it approximating more closely to the standard of a boy in his fourteenth year than any other measurement, showing that this tissue is developed comparatively early in life, and that its percentage of future increase must be small as compared with that of any other measured organ. The breadth of head rising to essentially the same percentile grade as girth shows that the form or shape of head does not essentially change during the period of growth. Physiology has taught us the early growth of the brain that reaches a fair approximation to its final size in the eighth year. At birth it is 14.34 per cent of the total weight while in the adult it is only 2.37 per cent. The muscles grow from 23.4 per cent of the weight at birth to 43.1 per cent of the weight in adult life, while the skeleton keeps at about the same proportional part of the total weight throughout active life, ranging from 16.7 per cent at birth to 15.4 per cent at maturity.

The next point to which attention is called is the large depth of abdomen and comparatively large girth of waist. This represents the infantile type and is followed, as will be seen by reference to the two lines upon the right of the chart, by a period of retardation in growth. The chest, to some extent, partakes of the same change in type, and shows that the "round chest," that is, the deep chest, is a primitive or infantile type.

It may also be well to note that in girth and breadth of neck we have illustrated what will be found true in studying the measurements of mature people, namely, that a large neck is usually found under a large head. and vice versâ—the neck developing as a support to the superimposed mass.

In strength we see the arm developed more rapidly than the legs—this again pointing to the rudimentary type, as demonstrated by Louis Robinson.

In studying the second line (boys 12–13 years) in relation to the first and the central straight line, we may note an acceleration in the development of lengths as compared with the first line and a retardation in other records as compared with the straight line. The strength tests show symmetrical but comparatively small increase, except in forearm. The girth and breadth of head show a slight advance, but comparatively the least increase of all the measurements. If, now, we study the fourth (14–15 years) line upon the chart and compare it with our central line, we see that it diverges more widely at all points than does the second line, while the fifth line (15–16 years) bears much the same relation to the fourth that the second bears to the first. The lengths have now outstripped the girths and breadths, while the girth of head and waist show a comparative retardation, which indicates an approximation to their completed growth. What is true of the head seems to be also true of the strength tests of the arm, while the strength tests of legs and trunk show marked acceleration, until they slightly outstrip the standard that might be expected from the girths. The depths show a retardation, like the head, and we see our boy evolving from the round primitive type into the broad form of the erect animal.

Let us now glance at these lines, bearing in mind the ages that they represent, for here they show in most

unmistakable manner the law of growth, as first demonstrated in this country by Dr. Bowditch in his classic paper. The period of the fourteenth year is a period of retarded growth, and is immediately followed in the fifteenth year by a period of greatly accelerated growth, this being the period of pre-pubertal acceleration, while the retardation is seen to be fully as marked as the acceleration and corresponds in its mathematical value closely to it. In other words, if we were to draw a line midway between the second and the fourth line it would represent on either side a year of what may be considered average growth, according to the standard set by the space between the first and second lines and by that between the fourth and fifth. In other words, the acceleration of the fifteenth year is sufficient to at least make up for the retardation of the fourteenth.

The question has often been raised as to the value of the percentile method in grouping small numbers of measurements, and much doubt has been expressed as to its value by prominent anthropometrists. The presentation of this table is an unanswerable argument in favor of the position taken by the author and others, that a small number of measurements is sufficient, when the group considered is complete, to produce a percentile chart that shall represent definitely the type of the group considered and that shall not vary more from the true type of the group than the probable error of the examiner, and consequently for practical graphic use will be as serviceable as a chart prepared from large numbers of measurements, especially where these measurements are collected by different individuals and from different groups, being subject to the personal equation of the examiner and the variations of the local types.

The growth of the male and female child correspond very closely until the eleventh year in both weight and

height. The boy is heavier at birth by one-fourth kilogram and taller by a centimeter. During the first week of life there is a loss in weight but after that epoch of adjustment to a new source of nutrition is passed the increment of weight is fairly steady until the eleventh year when the girl begins to grow more rapidly in both weight and height and outstrips the boy, remaining both heavier and taller until the fourteenth year, when the boy again becomes taller than the girl and in his next year he surpasses her in weight. This is shown graphically in Fig. 54, where the line AA represents the height

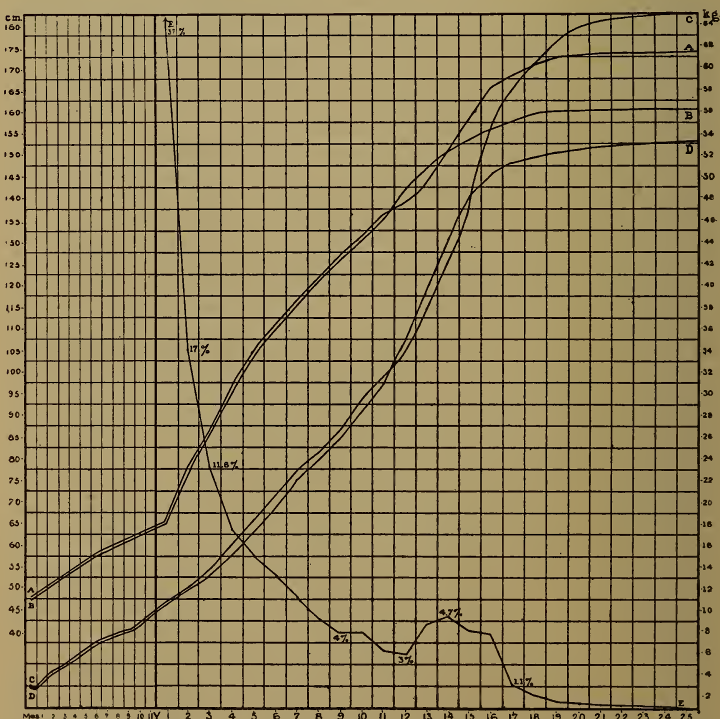


FIG. 54.

of boys and BB the height of girls; the line CC represents the weight of boys and DD the weight of girls. The line EE shows the percentage of growth in height for the various years and emphasizes the periods of retardation and acceleration more than the lines representing the actual increment.

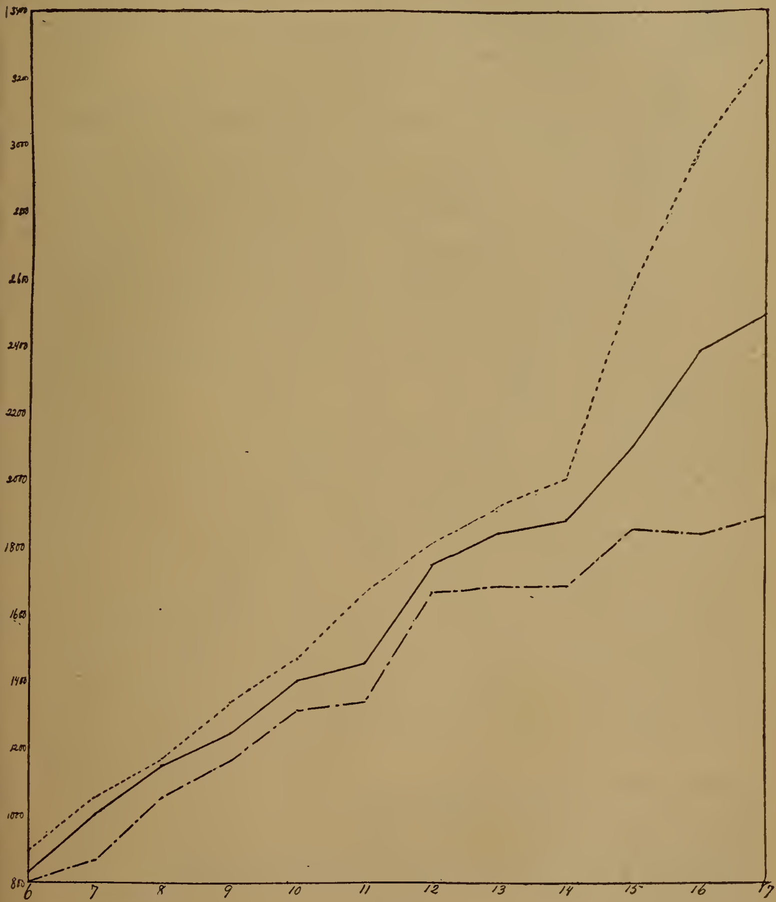


FIG. 55.

An interesting and valuable physiological fact is demonstrated in the growth of lung capacity as shown in Fig. 55,* this varying with weight and finally distributing the curves so as to represent essentially the proportions demonstrated by Kellogg as actually occurring in strength tests, and by Foster, Atwater, and others, as theoretically possible from the metabolism represented by the waste eliminated.

The variations in nerve ability are found to bear a close relation to the periods of abrupt variations in the curve of growth. This is shown in Fig. 56† where the dotted line represents the voluntary motor ability of boys, the broken line that of girls and the solid line both boys and girls.

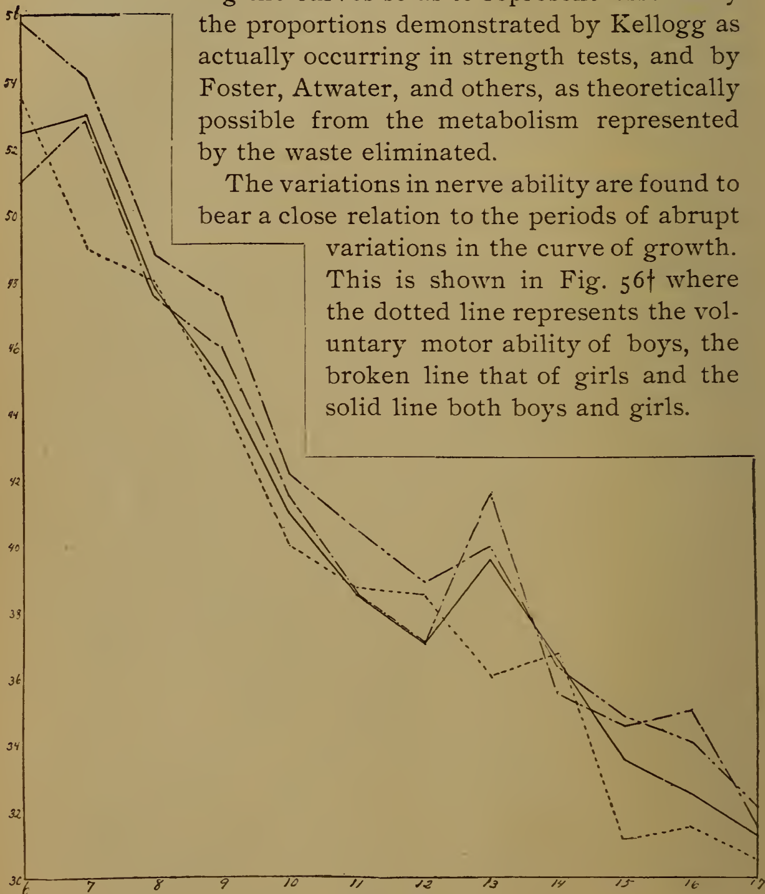


FIG. 56.

---

* Studies from the Yale Psychological Laboratory, Vol. II.

† Gilbert. Researches on the mental and physical development of school children.

CHAPTER IX.

EXAMINATION BY INSPECTION.

After the measurements of a person have been taken, the work of examination and physical diagnosis should begin. The measurement is mechanical and could be done correctly by any person after a little practice, but a physical examination requires the highest product of scientific training backed by sound judgment in order to discover the true condition of organs and determine the real cause of the disordered function or disturbed growth. It may require only a mechanical eye to discover a curved spine, but it must be the mechanical eye, backed by a thorough knowledge of physiology and anatomy, that can discern the fact and the cause.

Inspection should be made with the subject entirely nude and standing easily. If a military attitude is assumed, try to get relaxation into the ordinary positions. This can often be done by calling the attention to some trivial matter, as any peculiarity of the hands or feet, or by having the subject step forward or backward a few steps when he will forget his strained position. From the front notice (1) the general coutour or relative breadth, (2) the position of the head, (3) the position of the shoulders and arms, (4) the curves of the trunk and linea alba, (5) the muscular condition of chest, abdomen and legs, (6) any malformation, such as asymmetry, tumors, cicatrices, etc.

From the side notice (7) the antero-posterior or normal spinal curves, (8) the depth and mobility of the chest and abdomen, (9) the position of the shoulders, (10) the relation of the hips to the loins, or the pelvic tip, (11) the

relation of the neck to the trunk, (12) the general attitude of the subject, or the poise.

From the rear notice (13) any lateral or spiral curvature of the spine and prominence of spinous processes, (14) the condition of the shoulders and scapulæ, (15) the waist curves, (16) any tipping of the iliac crests due to one leg being shorter than the other or imperfect bone development, (17) the outline and position of the legs, as in knock-knees, bow legs, etc., (18) the muscular condition, (19) the condition of the skin, and (20) any tumor or malformation, varicose veins and cyanosis.

Of course the examiner will not look up each one of these points in regular order, but he should study each one and after an examination go over this list and see how many points there are on which he has no clear, definite knowledge, and then try on the next case to make the list smaller until he will take in everything at a glance, as it were. There are many other matters to which attention might be called, but they are mostly amplifications of the above list.

We include in (1) the breadth of head as giving some idea of the temperament and vitality of the subject. A broad head at the base is believed to indicate a greater vitality than is found when the head is long and "top-heavy." There is greater power of resisting disease and less liability to nervous irritability of a pathological character. A thin, weak neck means a bad curve forward at the cervical portion of the spine, and a consequent flat chest in a large majority of the cases. The voice will be uncertain and the throat suffer from catarrhal diseases on the slightest provocation. The circulation of the head will be poor and congestive headaches common.

Narrow shoulders mean compression of the upper part of the thorax, and less activity of respiration in the apices of the lungs. This, with a history of tuberculosis

is unfortunate, because tubercular degeneration usually begins at the apex of the lungs and an inactive part is an unhealthy part. This fact has led Dr. T. J. Mays to claim in an article published in the "Therapeutic Gazette," May, 1887,* that the wearing of corsets by ladies may be a protection against phthisis, because by compressing the abdomen and lower part of the thorax costal breathing with a freer use of the apices of the lungs was necessitated and a consequent immunity from tubercular degeneration was the result. The fallacy of this theory has been repeatedly shown but by no one so completely demonstrated as by Dr. J. H. Kellogg, whose investigations regarding normal respiration are complete and original.†

The breadth of chest is one of the three factors in making up the "Vital Capacity," and its relation to the breadth of waist and hips will give a better idea of the natural strength than the size of the biceps. Any depression of the ribs or sternum should be noted. I have seen a case of severe hepatic disturbance that had resisted medical treatment for many months recover more than ordinary health under a series of excerises that tended to lift two depressed ribs over the liver into a more arched and natural position.

Notice any elevation of the chest wall in the cardiac region, and any transverse depression at about the sixth rib. The elevation may be due to enlargement of the heart or pericardiac effusion. The depression is due to faulty habits of sitting—the person sliding forward in his chair and sitting on the sacrum, instead of on the buttocks. This depression causes a pressure on the heart and interferes with the circulation and also causes indigestion quicker than plum pudding by restraining the

* See "Med. News," Nov. 27, 1886.

† Transactions of the Mich. State Med. Society, 1888.

muscular activity of the stomach which is very marked during digestion. This "creased chest" is a postural deformity.

Under (2) we should note any position of the head that might denote a shortness of the sternomastoid muscles. A shortness on one side tends to tip the head toward that side and turn the face to the other; if both muscles are short they tend to draw the neck forward and tip the face up. This is a frequent condition and if well marked gives a very awkward poise, especially if in (7) we find the cervical curve very deep. or the neck slanting forward because of poor support from weak muscles. A strong neck is very desirable. It not only holds important organs in place and insures good circulation in the brain by making the channels direct but it gives an aggressive carriage, and indicates determination and pluck. In (3) we observe the slope of the shoulders and the relation of the acromions to the sternum. If a line be drawn from the tip of the acromion to the base of the neck and continued to the spine, it will make an angle with the line of the spine which should approximate to 80°. If the muscles that support the shoulder be weak, they permit the acromial tips to sink, making the angle less. while if these muscles be over-developed they draw the tips up and give a stiff, hunched appearance that is ungraceful. If the muscles in front be better developed than those behind, the shoulder will be drawn forward and down, giving an apparently flat chest with sloping shoulders, which is a mark of slack habits and lack of all exercise of a natural character. This form is sometimes seen among gymnasts who devote themselves to one kind of exercise, as horizontal bar practice, etc. The effect of this posture on respiration will be evident to every person with a knowledge of the elements of anatomy. The person has no energy or "sand" because his

blood is not properly aërated. The arms hang forward, giving the feeble, helpless attitude assigned by caricaturists to the innocent "dude."

By (4) we mean the outline curves of the waist which show something of the strength of trunk that may be expected, and the outlines of muscles that give the beautiful curves seen on the athlete. These lines may not be clearly cut in some cases of well developed muscles on account of the adipose tissue immediately under the skin, but in every healthy person they give character to the anterior wall which otherwise becomes as expressionless as a bag of meal. This last point will help us in estimating muscular condition (5) which cannot be judged altogether by size.

It is well to remember that, in (6), we must not only decide as to the character of the malformation but know what the prognosis or probable development will be—what interference with exercise will be caused and what exercises are contra-indicated—what will be the influence on health—what does it indicate as to the physical stamina or constitutional strength. For instance, varicose veins may never have given any trouble and may never have been noticed. How long could this condition exist unnoticed and what may be expected from it now? What exercises should be avoided, etc., etc.?

In surgery the word tumor means any abnormal enlargement of an organ or tissue. Perhaps the most frequent form of tumor that will be found is due to rupture or hernia. A hernia is a tumor caused by the passage of a portion of an organ through the bony, muscular or tendonous wall that normally confines it. It may be produced suddenly by a severe strain or bruise, or it may be the result of a gradual distension of one of the natural openings of the wall. Cases of intestinal hernia are frequently found, and among young men will affect two or

three per cent of all, while among those past middle life it will affect as high as six per cent. Among females it is much less frequent. This is due to the less patulous inguinal openings in the female and to less exposure in the daily avocations of life. Abdominal hernias are classed as inguinal, femoral, umbilical, diaphragmatic, etc., according to the place where the viscus forces its way through its natural support. The small intestine or the omentum is the tissue that usually protrudes.

An inguinal hernia may appear at the external inguinal ring as a round tumor of greater or less extent and is then called "direct," while if it appears first at the internal ring and passes down the canal it is called "oblique." The latter form is much more frequent and tends to develop rapidly downward, giving the tumor an elongated form with higher origin than the direct.

In femoral or crural hernia the intestine passes down through the crural ring under Pouparts' ligament where it causes a protrusion of the anterior wall of the thigh in a round tumor that lies in the groin just below the fold at the saphenous opening. It is situated farther externally from the median line than the direct inguinal and if large will have its axis in a horizontal rather than a perpendicular direction. A hernial tumor gives a marked impact to the finger of the examiner if firm pressure is made while the subject coughs.

These three forms of tumor must be readily differentiated from cystic tumors, varices, glandular enlargements, etc.

Cysts have a well-marked fluctuation. Varices have fixed relations to the venous trunks and subside on the subject assuming a horizontal position and fill again on rising even if the inguinal rings are supported. Glandular swellings are due to some attendant local irritation and are painful and unyielding to pressure. Each case

of hernia should be referred to the family physician or to a surgeon for advice and treatment. No gymnastic instructor should take the responsibility of prescribing exercise for such cases without advice. The same may be said of all tumors.

The antero-posterior curves of the spine (7) are a concavity in the cervical and lumbar regions and a convexity in the dorsal and pelvic. These curves may all be exaggerated by disease or occupation or muscular development. Any increase in the curves must shorten the total height. Any weakness of muscles at the back of the neck will permit the head to hang forward, thus increasing the dorsal convexity, producing round shoulders, or kyphosis. An over-development of the lumbar muscles as compared with those of the abdomen will increase the lumbar concavity, causing lordosis. The strong back is the straight back.

The gymnastic treatment of lordosis, or abnormal anterior curvature, is the only satisfactory one where there is no caries or breaking down of bone. The same is true of kyphosis, of which Dr. Stedman writes:* "A cure of adolescent kyphosis, when of slight degree, may be obtained by exercise alone, without mechanical support, but it will be found advantageous to aid the patient in maintaining an erect posture by suitable apparatus. The treatment by exercises in this form of kyphosis should never be omitted, since the fault lies chiefly in a want of tonicity of the muscular and ligamentous tissues."

If there is exaggerated curve at any part of the spine, there will be more or less compensatory curve in the opposite direction at other parts; and, in prescribing exercise, great care must be used in deciding which is the primary and which the compensatory curve, for an error

* Wood's Medical Reference Handbook. See, also, Lagrange's "La Medication par l'Exercise."

would make matters worse from the development of parts already strong, and the neglect of parts that are weak.

In observing the depth of chest and abdomen (8) and the movement of each under respiration we have a clue to the activity of the person. If the chest is deep at the sixth rib, but thin at the second, the sternum will usually be found unsupported by the muscles of the neck; those behind being weak and letting the spine slope forward at the upper part so that the sterno-mastoid and the scaleni muscles can not raise the chest. This throws all the work of respiration on the diaphragm, and the person is unfitted for any athletic exercise, and would have a cramp in his side if he were to run an eighth of a mile. It is said that a round chest of equal girth with a flat one will not show as great a lung capacity on the spirometer and my experience corroborates the statement if the extreme types are taken.

If the abdomen protrudes or sags so that the intestines seem to be held just above the pubic arch, especially if there be a history of hernia, or excessive corpulence, or indigestion, the matter is of such import as to call for thorough instruction and earnest advice. Much discomfort, ill health and physical suffering will be saved such cases, if the abdominal muscles be developed by persistent exercise—the abdominal cavity contains quite as important organs of health as the thorax, and the competent instructor will not spend all his time and efforts in developing the chest.

In (9) (10) (11) (12) we have some of the points that go to make up the carriage or general appearance of the subject, and they constitute the difference in physique between a West Point cadet and a slouching loafer.

Our rear view of the subject will disclose any lateral curvatures (13) of the spine, or scoliosis, and we should not only see any deformity of this character but should

be able to judge of its nature, and determine its causation. The curve may be simple and confined to one part of the spine, or it may be multiple. In the latter case one of the curves is usually the primary lesion, and the others compensatory. The reason for the compensatory curve is found in the natural effort to maintain an erect carriage. If there be a slight curvature to the left in the lumbar region it would tend to tip the shoulders to the right, but the natural effort to straighten the spine has most success where the muscle is stronger, and not at the point of greatest weakness, toward which the convexity lies. The result is the bending of the upper part into such a position that the weight is in equilibrium, and the shoulders fairly level. This effort to bend a higher portion of the spine to produce a balance of weight usually is the cause of a slighter curve higher up in the cervical portion, that restores the head to the erect position. Thus a curve to the left in lumbar region may cause another higher up to the right, in dorsal region, and another still higher to the left in the cervical portion of the spine. If this explanation is correct it is plain that the predisposing cause of scoliosis must be due, in a large majority of the cases, to the weakness or uneven development of the muscles and ligaments that support the spine. If the muscular strength and activity of one side be greatly in excess of that of the other, the spine must of necessity be drawn to that side which will throw the convexity toward the weaker side. If this principle obtains in all the anatomical relations—and its influence cannot be denied—no better argument could be used in favor of training for bilateral symmetry. In connection with scoliosis or lateral curvature of the spine there is nearly always a twist of the spinal column on its long axis producing a backward protrusion of one side while the other is pushed forward. This deformity is called

rotation and its importance is quite as great as the amount of lateral displacement. The rotation is seen more readily when the subject bends forward—one side then appearing higher than the other.

The fact that girls are affected by spinal curvature more often than boys (the proportion being four to one) would seem to indicate a need of more robust exercise out of doors or in gymnasiums that shall give such a development of the erector spinae mass, and all the muscles above the hips, as shall compare favorably with that of boys. The influence of corsets and stays has been repeatedly shown to be the cause of great muscular debility in the parts constricted, and all medical authorities assign a large part of responsibility for curvatures to their use. The lumbar muscles of the female have a comparatively larger field of origin at the pelvis and should be correspondingly strong, but under the differentiation of civilization and the corset, the female waist has degenerated into a bachache.

Pressure on a muscle tends to drive the blood out, and if it be continuous, the circulation is impaired. This condition means bad nutrition of the muscle, and that leads to imperfect development or to actual atrophy. Is it any wonder then that a physician hears from his female clients one long complaint of weak backs, backaches and general debility!

The remedial exercises for curvatures need only be suggested here, as the only treatment, is forcible straightening and proper exercises. The care should be exercised on the weakest spot, which, in some way, "must stand the strain." Suspension, as on the rings and bars, and the direct exercise, either active or passive, of the degenerate muscle, is the general plan of treatment.

The prominence of the spinous processes are of diagnostic value in locating weak spots. If the interspinous

ligaments have been strained and stretched by lack of muscular support or bad habits of posture, as sitting back on the hips, and letting the weight of the trunk press the lumbar vertebræ back, or a pernicious habit of letting the head hang forward, the saw-toothed appearance of the spine, as the subject bends well over, will disclose the fact. Notice the alignment of these processes as the subject is bent over and straightens up. A failure of one or two, here and there, to stand in the line, is not an indication of disease, but is due to a slight bend in the process, as will be seen on examinating almost any skeleton. The spinal curvature will be indicated by a number of them assuming a general curved outline.

The mobility of the scapulæ (14) varies greatly in different people. A more beautiful contour exists when the trapezius and rhomboïdei are strong and short, holding the scapulæ down and well back to the spine, but the range of arm movement is not so great. A good development of these muscles is very desirable as they prevent the shoulders from rolling forward and flattening the chest.

In (15) notice the size of the lumbar muscles, with the subject bent over.

It should be borne in mind that a shortness of one (16) leg is comparatively frequent and this deficiency causes the pelvis to tip with resulting spinal curvature. Distocia, or deformity of the pelvis may have the same effect. It is well to notice the comparative height of the dimples that mark the posterior superior spinous processes of the ilii, as they indicate to some extent the position of the base on which is erected the bony column of the spine. This base should be perfectly horizontal.

The bone of the legs (17) cannot be greatly changed by exercise, but something can be done in early life to relieve one of the burden of bow legs or knock knees.

Therefore, in the examination of children do not overlook this point, nor needlessly turn the attention of the subject to it when there is no relief, but occupy his mind with matters that can be improved and modified. In observing the legs notice any cyanosis about the ankles, and varicose condition of the veins, especially of the lower leg. In some persons the skin is firm and seems to fit the underlying tissues very closely, thus giving support to the venous walls, while in other cases the skin is relaxed and thin, furnishing poor support to the superficial vessels. If we recall the fact that the hydrostatic pressure alone in a person of ordinary height, while standing, would be trifle over one kg. in the vessels of the foot, and that the friction of the current along the vessel wall, the impediment from constriction of clothing and speed of the current, all add to this pressure we can readily see why certain classes of people are specially liable to dilation of the veins, and suffer accordingly. Persons obliged to stand much of the time without great change of position (as clerks, book-keepers, bench mechanics, etc.), and very fat people, who stand a considerable part of the time, are most often affected. The pressure on the external iliac vein in corpulent people is a predisposing cause, as it prevents the free return of the blood into the trunk, and the same may be said of garters, tight clothing on the thighs, or elastic thigh bands, tight belts around the waist, corsets, and any garment or device that prevents normal respiration (see illustrations, Chap. XIII.). The proper advice in these cases is clear. Restriction should be placed on all exercises like jumping, where the feet strike the ground hard; running on pavement, floors, etc., bicycle riding, because of the pressure of the saddle falls on the femoral and saphenous veins; violent exercises, like foot-ball, etc., etc. Light exercise should be encouraged, for, the better the

tone of the tissues, the less giving way will there be to pressure. Exercise of the skin to keep it healthy and firm—such as massage and cold water baths, to stimulate the contraction of the tissues—will be of assistance. In this condition "forewarned is forearmed" Cyanosis is a varicose condition of capillary veins and indicates poor circulation. In cyanosis about the trunk search carefully for some heart lesion.

The condition of the skin (19) will signify much to the careful examiner. Not that every subject with acne should be set down as dyspeptic, but in an almost intuitive way the careful observer will learn to diagnose many internal ailments and judge of vices that might otherwise be unknown. There is something that cannot be described in the healthy, firm, velvety skin of an athlete. It must not only be seen, but felt, in order to be appreciated. It is better to be rolled in the dust by a hearty, healthy wrestler than to shake the flabby, moist hand that is placed in yours by some advocate of moral suasion and intellectual top-heaviness. The skin, like the eye, is the mirror of the bodily health, if we only know how to see the image clearly. Its firmness, its elasticity, its smoothness, its moisture, its odor, its color, its warmth, all are full of meaning. Physicians often read the complaint in the countenance of the patient, before his mouth has uttered it. We have in observation not only the facial countenance but the expression of the whole body. How much, then, should we rightly judge of the inner man! The delicate tint seen on the skin of the woman who has exercised in the open air, until every tissue proclaims her the type of health, is as superior to the rusty covering of the dyspeptic house plant as that is superior to the hide of a pachyderm. Local diseases may deform the skin, but the indications of general health will be found, if it exists.

The following table will present in compact form some of the more prominent points observed by inspection:

GENERAL ASPECT.

- (1) Form.
  - Front View.
    - Aspect of chest.
      - Flat.
      - Round.
      - Bilateral asymmetry.
      - Sternum depressed.
      - Pectoral muscles.
    - " " waist.
      - Breadth.
      - Muscles.
    - " " legs.
      - Bow-legs.
      - Knock-knees.
      - Muscles.
    - " " neck.
      - Sterno-mastoid.
      - Lateral muscles.
  - Side View.
    - Poise of head.
    - " " thorax.
    - " " loins and belly.
    - " " hips.
  - Rear View.
    - Breadth.
      - Neck.
      - Shoulders.
      - Waist.
      - Hips.
    - Height of acromions.
    - Line of spinous processes.
    - Scapulæ.
    - Pelvic crests.
- (2) Nutrition.
  - Unduly thin.
    - Sickly aspect. } Atrophy.
    - Healthy " } Atrophy.
  - " fat.
    - Evenly distributed and firm.
    - Unevenly " and soft.
    - Fatty degeneration.
-
  - Eruptions.
    - Acne, furuncles, etc.
    - Eczema.
    - Psoriasis.
    - Tinea.
      - Circinatus.
      - Versicolor.
      - Tricophytosis.
    - Ulcerations.
    - Erysipelas.
  - Cicatrices.
    - Traumatisms.
      - Bruises.
      - Burns.
      - Cuts.
      - Lacerations.
    - Carbuncles, variola, etc.
    - Abscesses
      - Free.
      - Bone.

- (3) The Skin.
  - Tumors.
    - Sebaceous.
      - Comedones.
      - Seborrhœa.
      - Sebaceous cysts.
    - Hypertrophy.
      - Ichthyosis.
      - Goiter.
      - Condylomata, callus, etc.
    - Malformation.
      - Chicken breast.
      - Retained testis.
      - Funnel chest, etc.
    - Cysts.
      - Varicocele.
      - Hydrocele.
      - Hernia.
      - Abscess.
  - Discolorations.
    - Lentigo.
    - Chloasma.
    - Jaundice.
    - Erythema.
    - Purpura.
    - Cyanosis.
    - Bruises.

CHAPTER X.

EXAMINATION BY PALPATION.

The use of the sense of touch, or palpation, is of great importance in locating tumors and determining chest movements, viz: frequency of respiration, vocal fremitus, ronchi, frictions, etc. By the eye you can only imperfectly judge of size and consistency. An arm may be large, but, if soft and flabby, it does not indicate health or strength; while if it meets our hand with a proper resistance—not too hard nor too soft—we know that it is capable of good things, be it large or small. Palpation enables us to say how much fatty tissue underlies the skin, and how firm the muscle is under the fat. It is a mistake to set every person with abundant adipose tissue in the list of "muscles undeveloped." Nor is fat a substance of no worth to the physical economy and to be avoided. In certain quantities it is of the greatest advantage to health, and is an indication of high nutrition. It is so much physiological capital stored up, and is so located as to prevent loss of heat by radiation, especially over the more sensitive organs, and therefore saves the energy that would be lost in heat. This is nature's way of protecting her children from the increased severities of the season, for, as autumn brings presages of winter by her cooler nights, every animal, in health, grows fat, and those that are exposed to continued low temperatures, like whales, seals, bears, etc., lay up enormous stores of it underneath the skin, where it will do the most good, and over the abdominal organs and heart. If the supply of food is cut off, the fat is consumed to provide vital force for long periods of time. The same is true of man,

but to a less extent. As civilization has relieved him of many of the exigencies of nature, it has modified his requirements, restricting them in some directions, and enlarging them in others. The modern civilized man needs less fat than the Esquimaux, because he has a milder climate and better facilities for heating his house, but he needs some fat to prevent the irritation of the nervous tissues during the adjustments of heat production that are so rapid in a well-balanced body, when we pass from a cold to a warm atmosphere and the reverse. This strain is thrown on the involuntary or sympathetic nervous system, and this is the part that breaks down in the so-called "nervous exhaustion" or "neurasthenia," which is so common. Not that lack of fat stands in causative relation to this disease, but that one source of strain is found here. Such persons bear the cold badly and seek warmth, their treatment is warmth and nutrition. The argument, then, is that a fair amount of fat is conducive to health of the nervous system. The same may be said of all the other organs. The lean man has no extra physiological resource to fall back upon, if irregularities are forced upon him, either in the way of lessened food supply, or sleep, or greater demand on his energy, either physical or mental, and his comfort and health soon suffer.

By palpation we may also judge of the temperature and moisture of the skin, and thus estimate its activity in excretion. A healthy skin should be firm and velvety, even in texture and activity, slightly moist under ordinary circumstances but not wet, colored a delicate shade of pink, without being flushed or having dilated capillary vessels, as will be found common in the clavicular or scapular region. If the skin is hot and flushed, it indicates the presence of fever, or a local disturbance of circulation, due to deranged nerve activity. If the skin be

dry, and tends to form scales, the superficial circulation is insufficient, and bad digestion is a common accompaniment. Free exercise, shower bathing, massage and friction will set things to rights if persistently employed, unless the skin be affected by ichthyosis, which "is a congenital, chronic, hypertrophic disease," and hence will be but little benefited. Profuse perspiration is found frequently, and seems injurious only in prolonging bronchial inflammations and general catarrhal conditions, by keeping the clothing damp a large part of the time. There is also an increased liability to Bright's disease from high concentration of urine and chilling of the surface on slight exposure.

Hyperidrosis will be favorably influenced by active exercise, as the circulatory system will at that time be depleted by the free sweating, and will give up less moisture in a state of rest. After exercise the damp clothes removed, the sweat washed off in the shower bath, and the skin dried by proper massage, leave slight liability to "colds." Local hyperidrosis may seriously impair the health by keeping the feet damp and cold and thus induce catarrhal, pneumonic, and rheumatic conditions. Medical advice is to be recommended in such cases, if hygienic precautions—such as cold baths, frequent change of clothing, sensible shoes with cloth tops, proper diet and regular exercise—do not avail. At times the under and inner surfaces of the toes and the outside margin of the foot from the little toe back to the instep will appear white and swollen in these cases. This condition closely resembles large blisters from scalds, but is only a water-soaked, "parboiled," state of the epidermal layer, like that seen on the hands of washer-women after they have been in hot soap-suds for a half hour. The advantage of a cloth-top shoe in these cases is apparent when we think of the comparative ease with which moisture passes

through woolen fabrics as compared with difficulty of evaporation through leather.

A condition of anidrosis, or too scanty perspiration is frequent without evident impairment of health. The skin is apt to get very dry and harsh, especially in cold weather, and eczema of the hands result. In many of these cases there is no general sweating, even in extremely hot weather, and perspiration is not copious.

It may be well to explain that "perspiration" is the term applied to the insensible exudation from the sweat glands that is evaporated as fast as secreted, while "sweating" is the appreciable collection of this exudation in drops of greater or less abundance. (See Foster's Physiology.)

In addition to what we learn of the integument and muscle by palpation, we detect by it certain movements that characterize health or disease. If we place the hands firmly on the walls of the chest, letting the fingers press the intercostal regions, there will be felt a movement of the chest on each inspiration and expiration, if respiration be normal. Any failure in expansion is noticed if there be interference with the chest action, from muscular or mechanical cause, that is unilateral. There should be bilateral symmetry of movement, but this may be hindered by muscular soreness from rheumatism, neuralgia, traumatism, etc.; paresis of a muscle, or group of muscles; intrapleural effusions; new growths; or by solidification of the lung or any considerable part of it. Malformations may also interfere with bilateral symmetry of movement.

If the subject be asked to repeat some word such as "ninety-nine," or to count aloud, one, two, three, while the hands are on the chest, as above described, a peculiar vibration will be felt, which is known as the "vocal fremitus." This thrill, or vibration, is much more prominent

in persons with thin chest walls and low pitched voices, than where the wall is thickly padded with fat, and the voice in high key, on the same principle that the low bass strings of a piano, when struck, impart vibration to solid articles in the room in an appreciable degree, while the high notes have a less perceptible effect. The "vocal fremitus" is somewhat plainer on the right side, on account of the larger size of the right bronchial tube. A fremitus may be caused by other sources of vibration than the voice, as by a cough, by mucous rales, by pleuritic friction, and the splashing of liquid, when the chest contains liquid and air.

The "ronchial fremitus," due to mucous in the bronchial tubes, is frequently very marked in bronchitis, and felt by the subject himself; but the area is circumscribed in most cases. The friction fremitus of pleuritic inflammation is faint and local in character. In general, those diseases that produce solidification of the air cells of the lungs, without obstruction of the bronchial tubes, increase the vocal fremitus; while those that interpose more air, like emphysema, decrease it. Liquids diminish or check it altogether. The scapulæ interfere with the fremitus, as does the liver, the latter not conveying the vibrations, and, if pressing firmly against it, preventing the chest wall from doing so below the margin of the lung.

Palpation is of great service in the diagnosis of tumors. The fingers are to be placed on one side of the swelling, and gentle but firm pressure made on the opposite side of it with the fingers of the other hand, by a quick movement of the wrist. If the contents of the tumor are liquid a bulging will be felt under the fingers, caused by the displacement of the fluid, that passes as a wave through the tumor, distending the sac at one part to accommodate the liquid depressed at another. This peculiar wavelike motion, called fluctuation, can be well

studied by examination of a rubber water bag under varied thickness of covering, having the bag distended hard, and again with less water in it, but no air. In cases of ascites the wave impulse is readily felt across the abdominal cavity—a light tap with the end of the finger against the side being sufficient to start the wave. A close estimate of the amount of fluid can be formed in this way, as the wave simply continues through the liquid part, and is not propagated by the intestines or general tissues.

The apex beat of the heart may also be located by palpation in a large majority of cases. In many subjects the chest wall is thin, and the heart action strong, so that inspection can determine the apex impulse with tolerable precision; but if it fail to fall in an intercostal space, or the chest wall be thick, or the heart-beat feeble, palpation must be used. In this connection it may be said, that for this purpose the ear may be the organ of tactile, as well as of auditory impressions.

The character of acute or chronic inflammatory action can often be determined by palpation, as in swellings about joints. Tumors and impactions in the abdominal cavity can be diagnosed by this process and their general character determined.

CHAPTER XI.

EXAMINATION BY ASCULTATION AND PERCUSSION.

The condition of the internal organs is determined in several ways. Among the most frequently employed, because most satisfactory in results, is by listening to the passive and active sounds so far as they can be secured to the ear. The passive sounds are obtained by percussion, or striking the surface over an organ, either with the tips of the fingers or a rubber mallet directly, or by laying a solid surface, or the finger, firmly against the surface, and striking this. The first method is called immediate percussion, and is seldom used, except for hard, bony surfaces. The second is called mediate percussion, and is applicable to all parts.

The sounds obtained by percussion vary in quality, intensity and pitch. The quality of the sound obtained over the various organs can only be rudely described, but practice will give skill in distinguishing it. The intensity will vary according to the surrounding medium, and the pitch will vary largely through change in the organs that produce the sound.

The region of the body most frequently examined by percussion is the thorax. The abdomen, especially in conditions of disease, is often examined by this method (in connection with palpation), but without the satisfactory accuracy that is to be secured over the chest, although it enables one to distinguish the outline of solid tumors of hepatic, splenic or intestinal origin and the area covered by cystic enlargements.

The method of employing percussion is generally with the fingers, although, if many examinations are made

daily, it is well to use a pleximeter and percussor (see Figs. 19, 20). It seems to the writer that the appreciation of vibrations by the finger is of considerable importance in assisting the ear, and, therefore, that digital percussion is better than instrumental. The act is easily performed by laying the fingers of one hand firmly over the part to be examined, and, with the tips of the first two or three fingers of the other hand, or the middle finger alone, striking against one of the fingers imposed on the part with a firm blow, accomplished by a wrist movement of flection. The force of the blow may be varied to perceive the difference in resonance, quality, and pitch of the sound under the new conditions, as this may have an important bearing on our determination of the case. Forcible percussion sets in vibration deeper tissues, and, if their condition varies greatly from the superficial tissues, there will be a mixed quality to the sound that aids in identifying healthy activity, or disease, or abnormal position. For instance, if we begin at the right clavicle and percuss downward, until we reach the lower edge of the liver, we shall pass over lung tissue at first where the sound elicited under mild or forcible percussion is essentially the same; lower down we reach a part of the lung that contains the large bronchial tubes when the pitch is lower and resonance good, then still lower to a part that is backed by the upper convexity of the liver with only the solid diaphragm and lung between it and the chest wall. Here under mild percussion the resonance is unimpaired; but under a firmer stroke the resonance is found to lose its clearness and become duller, and this dullness increases as we percuss to the very edge of the lung, where the sound is flat (see Fig. 57). The term "flat," as applied to percussion sounds, is such a quality of tone as is produced when an organ containing no free gaseous element is set

in vibration by an impact. The word "dullness" is comparative only and denotes less resonance than should be expected under normal conditions.

In using the pleximeter, we press it firmly against the surface, and strike upon it with the rubber percussor.

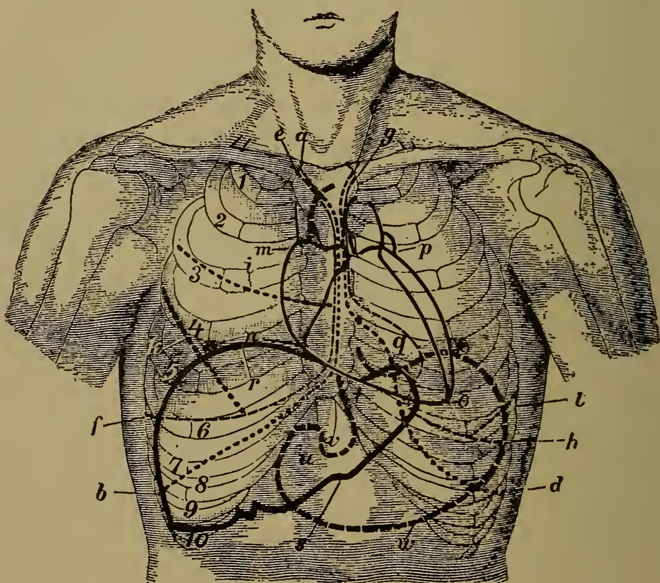


FIG. 57.

Showing the normal outlines and positions of the heart, lungs, liver, and stomach. The light dotted line shows the outline of the lung at inspiration, *b d*, at expiration, *f h*, and also the lobar divisions at *i k l*. The heavy continuous line shows the outline of the liver. The light line shows the location and divisions of the heart. The heavy broken line indicates the outline of the stomach. Luschka.

The resonance of the instrument is slightly confusing to the person who has been accustomed only to digital percussion, but practice soon enables us to eliminate this sound, as one does the sounds of mercantile life while listening to a voice in the telephone. Practice alone will

give skill in the determination of normal or abnormal sounds. It may be remembered that for any individual the resonance of the chest is fairly constant in health, but that of the abdomen varies continually; again, the resonance of the abdomen is always tympanitic or flat, while that of the healthy chest is neither. In making a physical examination, percussion of the abdomen is useless, unless there be a history of abdominal disorder, or inspection and palpation indicate something abnormal.

For convenience in describing any location on the anterior aspect of the trunk there has been a long-continued custom of dividing the body into a right and left half by a median perpendicular line and then designating the portion on either side above the clavicle as the supraclavicular region, right or left. The portion below the clavicle as far down as the third rib is called the infraclavicular region and the part covered by the clavicle is called the subclavian region. The mammary region extends from the third rib to the sixth. Below the sixth rib is the inframammary region, extending to the margins of the ribs. The lower sternal region extends from the ensiform cartilage to the third costal cartilage, and from this point to the sternal notch is called the upper sternal region. From the top of the stermine to the cricoid cartilage is the suprasternal region. The limits on the right and left are perpendicular lines drawn from the tips of the acromions. At the side the axillary region extends from the summit of the axilla to the sixth rib, and below this is the infra-axillary space, extending to the bottom of the chest.

The abdomen is divided into nine regions for purposes of description, as follows (Fig. 58): Draw a horizontal line across at the level of the narrowest part of the waist and a second line at the level of the iliac crests. Draw a perpendicular line from the middle of Poupart's liga-

ment, on each side, extending up to the chest. On the outside of these lines will be found, above, the right and left hypochondriac regions extending down to the first horizontal line. Between the horizontal lines will be the lumbar regions and below these the iliac regions bounded by Poupart's ligament. The central portion is called the umbilical region. Above this is the epigastric and below the hypogastric regions.

In examining a subject by percussion it is well to begin on the supra-clavicular region and percuss lightly and then forcibly *on each side*, and press the fingers well against the intercostal muscle rather than over the ribs, while proceeding to the lower edge of the chest; then percuss the right axillary region; then the posterior thoracic, from top to bottom, striking on alternate sides in order to discover any difference in sound that may exist, and then the left axillary space. There should be equal resonance of sound on each side behind, unless there be extreme unevenness of muscular development, which will slightly dull the sound on the strong side; but in front the location of the heart to the *left* of the sternum, and the liver to the *right* of it, and lower down gives a wide variation in sound for similar locations on the two sides. On the right we usually find the point of liver dullness beginning about 2 cm. below the nipple, while the line of flatness is about 6 cm. below it—the flat

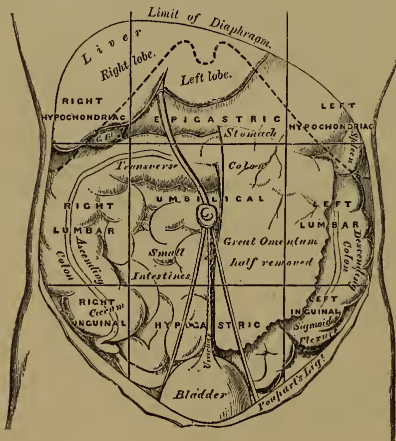


FIG. 58.

area extending about the breadth of the hand, or to the edge of the ribs, and around to the spine (see Fig. 59). On the left the area of heart dullness begins at about the third intercostal space, near the sternum, and extends out to a point nearly an inch above the nipple, and down

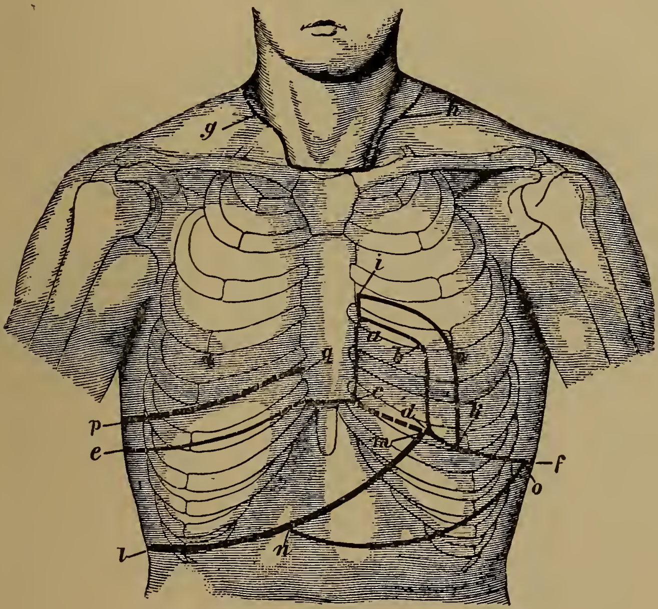


FIG. 59.

Showing the areas of percussion dullness and flatness over heart, liver and stomach. *i k* line of beginning dullness around the heart. *a d b c* area of flat sound or without pulmonary resonance. *p q* line of dull area over the liver. *e c m l* area of flatness over liver. *m n o* area of varying resonance over the stomach. Weil.

for 3 cm., shading off into the flat heart area—that is circular above about 5 cm. in diameter and having its center at a point half way between the nipple and the center of the end of the sternum, and reaching downward to the sixth rib, where it is merged in the stomachic resonance (see Fig. 57.)

The line of stomach dullness is of variable location and may not be perceptible at all.

The percussion sound of the abdomen is tympanitic or flat, according to the existence of gas in the intestinal canal. In case of ascites, a peculiar wave impulse is started by immediate percussion that is readily felt by the other hand held against the abdominal wall opposite the point of impact. The same is true of cystic tumors in other locations, where the walls are protected only by soft tissues, as in effusion into the synovial cavity of the knee and other joints, as a result of inflammation or hemorrhage. This wave impulse corresponds to the fluctuation of palpation. (See page 152.)

The area of liver dullness should not extend below the lower edge of the ribs, on the right side, while the spleen is found well around to the left side, extending from the line of dullness at ninth rib, downward about eight cm., the breadth being about half this distance (Fig. 59). In ordinary cases the spleen is not to be sought, as its function is not fully known, and its recognized abnormalities are confined to malarial and congestive fevers, with occasional malignant growths. The length of the thorax will be found to vary greatly in different people, and, where the ribs come well toward the umbilicus, the liver should hardly reach to the lower edge of the ribs, except in front, while in the cases of short chest it may extend five or more cm. below the free margin. The left lobe extends across the median line for about six or eight cm. (Fig. 59), where its limits are not readily discovered by percussion, on account of the area of heart dullness. At the right side the liver extends down to the tenth intercostal space, and behind it reaches to the last rib (Fig. 60).

It should be remembered that the lower limits of the liver may very greatly without its being an indication of

enlargement or disease. In examining this organ, therefore, it is well, if any apparent malformation exists, to determine by percussion, and mark with a flesh pencil the outline of the organ. The exact measurements can then

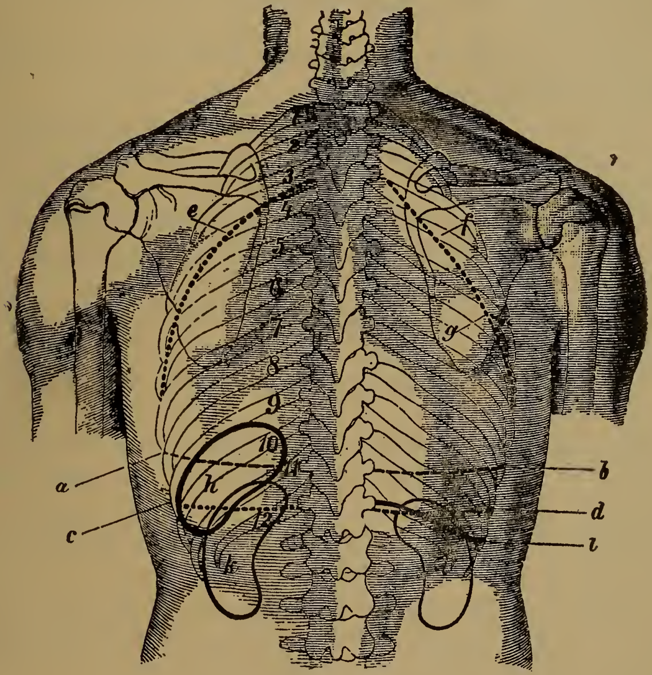


FIG. 60.

Showing the positions of the kidneys, *j k*, and spleen, *h*; margin of liver, *l*. The dotted line, *e f g*, shows the lobar divisions of the lungs. Scheube.

be made and malposition differentiated from hypertrophy.

Some of the more common causes of malposition are tight lacing, pleuritic effusion, congenital and traumatic malformations, pericarditis with effusion, and certain abdominal tumors. For convenience in treating the nor-

mal positions of certain organs, the following points should be fixed in mind:

The sternal notch is on a level with the top of the second dorsal vertebra or tip of seventh cervical spine.

The spine of the scapula is on a level with the third dorsal spine.

The lower angle of the scapula is on a level with the seventh dorsal spine.

The base of the heart lies at the fourth dorsal spine.

The apex of the heart lies at the level of the eighth dorsal spine.

The apex of the lung lies opposite the seventh cervical spine and vertebra, and from two to four cm. above the top of the sternum.

The base of the lung is on the level of the tenth dorsal spine.

The spleen lies on the level of the ninth and eleventh dorsal spines.

The upper convexity of the liver lies on a level with the eighth dorsal spine or slightly above the lower end of the sternum.

The nipple usually covers the fourth intercostal space at level of sixth spinous process.

These locations are all referred to the spinous processes of the vertebra as fixed points that can always be found. If we rub the ball of the thumb firmly down the furrow between the erector spinæ muscles, the tips of the spinous processes will show as pink spots on the skin. This method is recommended by Dr. Holden to determine the existence of lateral curvatures.

In auscultation we have the method of most precise knowledge in diagnosis. By other methods of examination we may learn that there is something wrong, but the ear is the supreme court to decide the case and tell what that "something" is. For purposes of auscultation

several instruments have been devised, but none better for general use than the binaural stethoscope of Dr. Camman, Fig. 17, with its improvements for clasping into the ears, without undue pressure. The unassisted ear is able to do all that is required in most cases, as the sounds are equally distinct, but the ear cannot be readily applied to all parts of the chest, and to attempt it in some cases would be to affect other parts of the sensorium with more profound salutations.

The stethoscope also enables us to localize sounds closely by making a direct course of travel for sound-waves. Consequently, it readily transmits those waves that pass directly into its bell or tube, while those waves that are not thrown directly in, are either lost or become obscure, so that our attention is centered on the sounds produced directly beneath. The pressure of the aural tips closes the external meatus of the ear, so that foreign sounds are entirely eliminated.

The following points in the use of the instrument should be borne in mind:

1. Apply the instrument to the ears so that the aural tips will point *downward* and *inward*, thus following the direction of the meatus of the ears.

2. Have just sufficient pressure in the ears to hold the instrument steady and make the tips fit perfectly.

3. Let no foreign material touch against the stethoscope at any part of it during use, as friction-vibrations will be set up.

4. Press the bell firmly over the spot to be auscultated, so that it fits the integument perfectly all around. If the surface is uneven the soft rubber bell should be used.

5. Do not let the fingers move on the instrument while holding it in place.

6. Always apply directly to the skin, as nothing satisfactory can be heard through even a thin layer of cloth.

7. The examiner should keep his own head as nearly erect as possible to avoid cerebral congestion from venous constriction.

Where the naked ear is used a soft cloth can be interposed between it and the subject.

In listening to the sounds of the mitral and tricuspid valves with a stethoscope, it is well, should there be doubt in diagnosis, to place a thin cloth, like a napkin, on the chest, and auscultate through it. The only sound heard through this will be the valvular click—the first sound becoming short and uncomplicated like the second sound.

In auscultation continued practice must be given to learning normal sounds and their relations. If the examiner knows every healthy sound with its variations, he will instantly recognize an abnormal one, even if he is not able to clearly state or even understand the existing lesion. Some sounds are so complicated as to defy experienced surgeons in reading their significance.

The following points are to be studied:

(*a*) Muscle-sounds, by placing the stethoscope over a muscle like the biceps, during its contraction and relaxation.

(*b*) Heart-sounds, by studying the sound at each location in the precordial region and along the large arteries.

(*c*) Lung-sounds, in every region of the chest.

(*d*) Intestinal-sounds, that are caused by the gases of fermentation.

(*e*) Succession or splashing sounds of fluid in the stomach (or chest), while it contains free gas.

(*f*) The "bruit" or hum heard in many cases over the large venous trunks, especially of the neck and upper chest and over aneurismal sacs.

A muscle sound is of low pitch and vibratory quality—a rapid throbbing as it were. Its character is repre-

sented in exaggerated form by moistening the end of the thumb and then rubbing it along the surface of a wooden table with a fairly rapid movement. The thumb will jump along the surface giving a low vibration to the wood. This muscle sound is the cause of the peculiar, prolonged "booming" sound of the heart during its contraction, and it modifies the valve sound of closing to some extent; therefore the directions on page 28 should be followed if there is an apparent systolic murmur.

The valve sounds are brief in duration, of high pitch and clicking or non-resonant quality. These sounds are confused more or less by the muscle sound, by respiration sounds and by the vibrations of blood currents both normal and abnormal. These abnormal sounds are generally of blowing quality and are called murmurs. They will be studied more at length in Chapter XII. The sounds of the normal heart must be patiently studied with the stethoscope until its every peculiarity is familiar; its rhythm, its force, its various valve sounds, its points of clearest differentiation of complex sounds and its transmission of sounds, the relation of the pulse in various localities to heart impact, etc. It is only by a thorough acquaintance with normal conditions that the abnormal can be recognized.

There will be found frequent cases of arterial and venous murmurs or humming sounds that will be likely to be mistaken for heart murmurs. These have a location over the larger blood vessels and the sound is continuous rather than intermittent, if of venous origin, and if arterial, the sound is usually not heard at the heart, but at some point where a large trunk makes a sharp turn or is narrowed by pressure of adjacent structures, as in the subclavian artery. The venous murmur may vary from a low hum to a whistling sound. The jugular vein is the spot where the venous hum is most frequently

heard, and in many cases a hum can be produced by an uneven pressure of the stethoscope, making a slight constriction in the calibre of the vessel. Turning the face of the subject to one side will sometimes produce a hum on the opposite side. This sound has been called by some writers an anaemic hum, but its cause can hardly be assigned directly to the quality or quantity of the blood. Anaemia might be a factor in the production of the sound by causing a softening of the tissues supporting the vessel, and the watery venous blood may be sonorous to a larger extent than arterial blood, as taught by Walshe, but the direct cause must be the unevenness of the calibre of vessels, through which blood must be flowing at a speed bearing some relation to the size of their lumena.

Arterial murmurs may be due to roughness of the inner coat due to inflammations or vegetations, sacculations, or pressures. These causes would produce systolic murmurs that would be loudest over the site where they are produced. From similar causes murmurs may be produced in the cavity of the heart itself. Another class of murmurs is found in extremely nervous people, excessive tobacco users and over-trained athletes. It is due to irregular muscular action of the heart, with consequent imperfect closing of the valves, and is therefore systolic and heard more commonly over the base of the heart. These murmurs are not constant, and do not frequently, if ever, exist with benign hypertrophy.

Heart murmurs due to dilatation of the cavities from anaemia do occur, and in those cases it is difficult to decide whether there is aortic obstruction or a simple dynamic murmur. In the first case, however, we would find a powerful heart impulse from hypertrophy, while in the second there would be a feeble impulse from the imperfect contractions. At times the respiratory sounds may

confuse the heart sounds by the air being driven out of a portion of the lung by the heart impulse, giving rise to a sound that may be mistaken for a heart murmur. This sound would be systolic and not heard at the apex.

It is well, then, in examination, to apply the stethoscope to the apex of the heart first and then over the base, listening carefully to the valvular sounds and asking the subject to suspend respiration in expiration for a moment if any abnormal sound is heard. Then listen over the carotid and subclavian arteries on each side. If a humming sound is heard that cannot be understood, let the subject take some of the gentler strength tests, and after a slight acceleration of the pulse listen again, and so proceed until he understands the case. The case may not be one to be determined in a few minutes or days.

CHAPTER XII.

THE SIGNIFICANCE OF CERTAIN PHYSICAL SIGNS.

In listening to the sounds of the lungs we must also have a fixed idea of the normal before endeavoring to study abnormal sounds. In perfect health the normal vesicular murmur of the lungs varies within quite wide limits of force, pitch, quality and duration, due to the difference in thickness of the chest wall and the activity of respiration in different individuals, but the general character of the sounds remains the same.

This sound has been likened to the faint rustling of dry leaves or straw, but the only description that is of help to a student is the one that he makes to himself by continuous use of the stethoscope and naked ear applied to the chest.

The following points may be borne in mind as helpful in examination:

1st. The murmur is shorter in expiration than inspiration, and in some cases the murmur is entirely suspended during expiration.

2d. The murmur is harsher over the region of the larger bronchial tubes, becoming milder as we pass downward to the base.

3d. The heart sounds will tend to confuse the lung sounds in the front of the left lung, but only in a few cases is it difficult to hear only the sounds you search for.

4th. The sounds of bronchial breathing are heard in simple, uncomplicated form, over the trachea and upper sternal region.

5th. The quality of bronchial respiration sound is tubular and harsh; the pitch is high.

6th. The expiration sound is longer than inspiration in the region of pure bronchial breathing.

7th. Vesicular or fine respiratory murmur is heard to the lower margin of the lung tissue.

8th. If the murmur ends abruptly at any point above the natural border of the lung, and the murmur is normal, suspect an effusion into the chest cavity.

9th. Normal flatness may begin as high as the sixth rib on the right side, and at the seventh on the left.

The abnormal respiratory sounds are called râles. They are in general of the bronchial type rather than the vesicular. The sounds may be dry and rasping as when the tubes are contracted by an inflammation at the initial stage or a spasm of the muscular fibres of their walls or by local pressure. The sounds are called moist when the tubes are obstructed by more or less fluid. These râles may be so loud as to obscure the vesicular murmur.

The crepitant râle is a fine dry, crackling sound, heard in the last part of inspiration in pneumonia and phthisis, and has been compared to "the sound produced by rubbing a small wisp of hair between the thumb and finger near the ear," "pulling postage stamps apart," etc.

The subcrepitant râle is heard in bronchitis, pneumonia, oedema of the lungs, phthisis, etc. It is a fine, moist, bubbling sound, heard in both inspiration and expiration.

Coarse bronchial râles are heard in bronchitis, phthisis, etc., and are caused by mucous interrupting the flow of air. These râles may be so loud as to be heard without applying the ear to the chest and if the mucous is very dry a whistling sound will be produced.

Gurgling râles are sometimes heard, especially if the subject is very weak and cannot expel thin mucous from the larger tubes or if there is a cavity in the lung from tubercular degeneration.

Aside from the respiratory sounds the vocal resonance is of importance in determining the condition of the lungs.

1. The *laryngeal voice* is heard over the trachea and large bronchial passages, while in the general area of the chest the sound is modified and softened, until the vocal expression is lost except over the right bronchus, and, in thin persons, the left.

2. This tone with "far-away" quality is known as the *pulmonary resonance.* It corresponds to the vocal fremitus of palpation.

3. Increased resonance indicates some consolidation of the lung without closure of the bronchial tubes, cavities, pleuritic adhesions or compressed lung tissues from effusions.

4. Diminished resonance is due to obstruction of the bronchi or a layer of fluid between the lung and chest wall.

5. Suppressed resonance is caused by large effusions in the pleural sac, with compression of the lung or new growths.

6. Broncophony or a development of the bronchial type of resonance in unusual locations indicates a condensation or hardening of lung tissue or cavities.

7. Amphoric resonance indicates very large cavities or pneumohydrothorax. The quality of the sound is musical and metallic; the pitch and the resonance hollow and without articulation.

8. Whispered resonance is found in as many forms as vocal resonance, and its modifications are due to the same causes. It is a more delicate test of slight consolidation and hence should be thoroughly studied. In normal cases it presents a soft blowing sound at the upper part of the chest only, where consolidation usually begins.

9. A cough resonance is helpful at times in securing

cumulative evidence of a condition suspected from other sources of information. This is specially true of the diagnosis of cavities.

In considering the sounds of the heart it is well to bear in mind the anatomical features of the heart, and the course of the blood as it passes into the heart and through it to the aorta. The blood from the lower parts of the body is conducted by the inferior vena cava to a point near the heart where it meets the current brought from the upper parts by the superior vena cava, and unites with it to form the innominate vein which empties into the right auricle after a length of 30 to 40 mm. There is no valve at the mouth of this vein, but blood can flow backward through it under pressure. The right auricle is a pouch-like sac with only a small amount of muscular fibre in its wall. This auricle acts as a reservoir of a fairly steady current whose contents are discharged at intervals into the ventricle or muscular compartment directly below it. This act of discharge is easy during the period of diastole or relaxation of the ventricular muscle, and is accomplished by gravity and the contraction of the auricular walls. When the ventricle is distended with blood the muscular walls begin to contract, and the blood is forced toward the two openings, the pulmonary artery and the auriculo-ventricular passage, but this latter is fringed by the tricuspid valve which is quickly closed by the current and the blood sent on to the lungs. At the opening of the ventricle into the pulmonary artery there is a valve composed of three semilunar flaps of pocket shape, which prevents a return current after the contraction or systole has ceased.

After passing through the pulmonary tissue the blood comes back to the left side of the heart and enters the left auricle by the pulmonary veins which are unguarded

by valves to prevent a regurgitation. The right auricle is very similar to the left in function and anatomical character. From it the blood passes down into the left ventricle during its period of diastole, and is prevented from flowing back during the powerful contraction of the ventricle by the mitral or bicuspid valve. This closure of the auricular orifice leaves only the opening of the aorta by which the blood must be driven out, and which then conducts it to the general circulation. At the aortic opening are located semilunar valves to retain the blood that has once passed into the arterial trunk, so that it cannot flow back and refill the ventricle during its period of receptivity.

It is clear, then, that in normal heart action we must have four valvular sounds, and these must all originate at points at no great distance from each other. In fact a circle of 25 mm. radius drawn from a center at the sternal end of the fourth costal cartilage on the left will cover the four valves. There are points, however, where each sound is heard more plainly, and these are for the mitral valve at the apex of heart; for the aortic valves at second intercostal space just at the right of the sternum, and over the right common carotid artery; for the tricuspid valve at middle of the sternum at the level of the nipple; for the pulmonary valve at the left of the sternum in the second intercostal space. The mitral and tricuspid sounds must be at the beginning of the systole, and are called the first sound of the heart, while the semilunar closings will be at the end of the systole, and are called the second sound of the heart. The first two sounds are synchronous and also the last two.

The first sounds are prolonged by the muscle vibration into a full booming sound, while the second sounds are short and clicking. Foster illustrates the difference by pronouncing the words loob-düb in the same relative

time at the heart sounds. Between the second and first sounds is an interval that is essentially two-fifths of the time required for a complete cycle of heart action. This is called the period of rest.

The following table is a summary of normal heart sounds:

NORMAL HEART-SOUNDS.

Sounds.	*Location.*	*Where Heard.*
1. Muscular.	Within boundary limits of heart or precordial area.	Heard best at apex and just above.
2. Mitral valve.	Behind the 3rd left intercostal space and 4th costal cartilage about 20 mm. from sternum.	Just above apex beat and at 3rd intercostal space on left of sternum.
3. Aortic valve.	Behind the left edge of the sternum at the level of the 3rd intercostal space.	At 2nd intercostal space on right of sternum, and over the common carotid arteries.
4. Tricuspid valve.	Behind the sternum at the level of the 4th costal cartilages.	At lower end of the sternum above the ensiform cartilage.
5. Pulmonary valve.	Behind the junction of the 3rd costal cartilage with the sternum on the left. About in front of the aortic valve.	At 2nd intercostal space to left of the sternum.

The boundary limits of the heart as given by Holden are as follows:

For the base draw a horizontal line over the third costal cartilages extending 12 mm. to the right and 25 mm. to the left of the sternum. For the apex draw a perpendicular line 50 mm. long downward from the left nipple and from its lower extremity draw a horizontal line 25 mm. to the right, which will bring the pencil over the apex to the heart in the fifth intercostal space. The nipple is usually located over the fourth intercostal space. From the apex draw a curve to the end of the sternum, and continue it up more sharply to the right edge of the sternum, and continue it upward to the right end of the

base line by a gentle curve. The left side will be marked by a curve of about 200 mm. radius extending from the left end of the base line to the apex (see Fig. 57).

The part of the heart not covered by lung tissue is inconsiderable, and is described by Dr. Latham as being outlined roughly by a circle of 25 mm. radius drawn from a center half way between the nipple and lower end of the sternum (see Fig. 59).

Abnormal heart sounds are usually called murmurs, and result from four causes:

1. The failure of valves to perfectly hold the blood from leaking through.

2. The narrowness of the opening through which the blood is forced into a tube of larger caliber.

3. Friction of the external surface of the heart against an inflamed pericardium.

4. Friction on endocardium from vegetations.

The first cause may be due to active inflammation of the valves from endocarditis, etc., that produces vegetations or uneven thickening of the valves and therefore imperfect closure, or the walls of the heart may become so distended as to prevent perfect coaptation of the valves. Other causes also may produce imperfect closure.

The second cause usually depends on inflammation that has caused a deposit of fibrous tissue around the orifice affected.

The third cause is more often the result of an injury or strain, and is found in some cases after violent exercise.

The fourth is found after fevers, rheumatism, etc.

The character of these abnormal endocardial sounds is hissing or blowing, and for this reason they are called by some writers "bellows murmurs," while the friction sound is more squeaking or grazing in its quality, and can frequently be diagnosed by the fremitus discovered by palpation.

The pitch varies in all the sounds from a low, gentle murmur to a high whistling note—the pitch giving us some idea as to the size of the opening; for if the sound be caused by a stream forced through a small aperture the pitch will be higher—the surfaces set in vibration being much shorter than in the large opening.

The most common heart lesion is a failure of the mitral valve to perfectly close the left auriculo-ventricular passage. This is called mitral insufficiency. It is plain that any fault in the closing of this valve would permit the blood to flow back into the left auricle during systole, and that this would cause increased pressure in the auricle and pulmonary veins, thus interfering with respiration and distending the auricle. As the heart contraction forces blood into the aortic arch, there is an effort toward straightening the aorta from the pressure, and this brings the apex of the heart against the chest wall at about the fifth intercostal space. This brings a continuous vibratory medium of solid tissue from the point of vibration to the external surface where we may receive it by the ear or stethoscope. We also find that the sound is carried to the left axillary region along the fifth or sixth rib. The sound is heard over the valvular region at the base of the heart but without characteristic qualities. The time of the murmur is during the systole, and hence it begins with the valvular click of the first sound and ends with the second valve closing at the aorta which gives the second sound.

If the heart sounds are so deranged that it is difficult to decide which is the first sound, it may be determined by remembering that it is synchronous with the impact of the apex against the chest wall, and also with the pulse wave in the carotid arteries. The following sphygmogram shows the typical disturbance of arterial pressure in mitral regurgitation (see Fig. 61).

The curve is not abrupt in the systole, and the pressure is not sustained to the dicrotic wave. If the systole is very energetic the pulse would be large but soft. The rhythm is irregular. Fig. 62 shows mitral regurgitation with slight aortic insufficiency. In order to understand the meaning of these curves, let us study briefly the normal pulse tracing (Fig. 63).

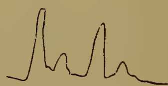


Fig. 61.

Fig. 62.

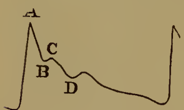


Fig. 63.

"All scientific investigators agree that the line A represents the cardiac contraction, the impulse being conveyed to the needle through the arteries in the same manner that the impulse is given to the last marble in a row of marbles by striking the first marble in the row a quick blow, the difference being that the row of marbles does not advance, while the blood current does. This ascent we will call the systolic wave.

"The arteries thus suddenly filled begin immediately by virtue of their elasticity to contract and the needle descends to the point B. Next we have a wave, the cause of which is not definitely settled. It is generally believed that the wave B–C, called the tidal wave, is due to a rebound of the blood from the terminal vessels or capillaries, for the following reasons:

"The tidal wave is more perceptible nearer the capillaries.

"The base of tidal wave approaches the systolic line and systolic apex the farther the tracing is taken from the heart.

"Sweating renders the tidal wave less perceptible and the base nearer the dicrotic notch.

"From C the artery again contracts till the needle reaches point D. The rise at D is generally conceded to be due to the rebound of blood from the closed aortic valves and is usually termed the dicrotic wave. The remainder of the cycle represents the diastole or rest of the heart."*

Fig. 64.

Fig. 64 shows a normal pulse of high tension and Fig. 65 a normal pulse of low tension.

Fig. 65.

The lesion that stands second in frequency is obstruction at the aortic orifice—any narrowing of this opening that makes its caliber less than that of the aorta will pro duce a murmur and tend to increase the work of the ventricle with resulting hypertrophy. It obviously does not menace life and health to the same extent as mitral insufficiency. The sound being produced by the current forced out by the contraction of the ventricle it must be synchronous with the systole and end with the second sound of the heart. Its location being at the base of the heart, we would expect to find the sound clearest at the beginning of the aorta. It is in fact heard most distinctly over the sternum at level of the second rib or just to the right of the sternum, and is also heard over all the large arterial trunks of the upper thorax and neck. It is called aortic stenosis.

Fig. 66.

Fig. 66 illustrates the typical pulse tracing in this lesion. The systolic curve is not abrupt nor high, but the pressure is well sustained past the dicrotic notch. The pulse is small and usually regular.

The third lesion in frequency is a regurgitation of blood through the semilunar valves from the aorta into

---

* See an article on "Use of the Sphygmograph," by Dr. J. G. Smith, in An. Rep. of the Amer. Assoc. for Adv. of Phys. Ed, 1888.

the left ventricle. Evidently this can only occur during the diastole of the heart. It should be heard in the same locations as the murmur of aortic stenosis, and also down along the sternum. The lesion is termed aortic insufficiency.

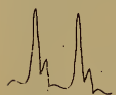


Fig. 67.

The interference with the pulse is shown by Fig. 67. Its characteristics are marked. The systolic curve is high and abrupt. The fall is abrupt. The dicrotic wave is small. The pulse is quick and strong—the "bullet" pulse.

The fourth lesion producing a characteristic sound is mitral obstruction due to stenosis of the left auriculo-ventricular passage. This would interfere with the passage of blood from the auricle to the ventricle in the period of diastole. The murmur being started during the stage of auricular contraction and ending with the beginning of the first sound; it is called presystolic. It is heard over the mitral valve and at the apex of the heart, but is not transmitted over a large area. This lesion leads to much pulmonary disturbance on account of the increased blood pressure in the lungs.

The fifth lesion is obstruction of the pulmonary orifice from stenosis. This would place extra work on the right ventricle, which hypertrophies by natural accommodation. The murmur must be systolic and heard over the second cartilage to left of the sternum. It is prolonged upward and to left of the sternum for only a short distance as the artery soon divides into small branches to ramify through the lungs.

The sixth lesion is a regurgitation through the tricuspid valves due to insufficiency of the closure. It is systolic and causes great increase of venous pressure by the current forced back into the auricle and through it into the venous trunks causing a venous pulse. It is heard at junction of ensiform cartilage with the sternum and to the apex.

The seventh lesion is an obstruction of the right auriculo-ventricular opening by narrowing, and hence the murmur must be presystolic.

It is heard over the middle of the sternum at level of fourth cartilage, and is not transmitted except to a slight extent downward to the end of sternum. It is called tricuspid stenosis.

The eighth lesion is a regurgitation through the valves (semilunar) at the opening of the pulmonary artery, and is termed pulmonary insufficiency. It tends to enlargement of the right ventricle, and interferes with the pulmonary circulation and aëration of blood. In time it must be diastolic, and is heard at the region of the second left costal cartilage. The sound is carried along the sternum faintly.

A murmur is transmitted, in general, by the blood and hence in the direction of the current.

TABLE OF ABNORMAL HEART SOUNDS.

Condition.	*Heart Sound.*	*Heart Action.*	*Where Heard.*	*Transmitted.*	*Lesion.*
1. Mitral regurg.	1st. sound.	Systolic.	Mitral area and apex.	Along 6th rib to axilla.	Mitral insuf.
2. Aortic obstruct.	" "	"	2d. rt. cost. cartil. at sternum.	To top of sternum and arterial trunks.	Aortic stenosis.
3. " regurg.	After 2d sound.	Diastolic.	2d. rt. cost. cartil. at sternum,	Down along sternum.	Aortic insufficiency.
4. Mitral obstruct.	" " "	"	Mitral area and apex.	Not transmitted.	Mitral stenosis.
5. Pulmon. obstruct.	1st sound.	Systolic.	2d. left cost. cartilage.	Up a short dist., ends abruptly.	Pulmonary stenosis.
6. Tricusp. regurg.	" "	"	Just above ensiform cart.	Down a short distance.	Tricuspid insufficiency.
7. " obstruct.	After 2d sound.	Diastolic.	Sternum at head of 4th rib.	Not transmitted.	Tricusp. stenosis.
8. Pulmon. regurg.	With 2d sound.	"	2d left costal cartilage.	Up a short distance.	Pulmonary insufficiency.

If these lesions be tabulated in the order of their frequency it will be observed at once that the left side of the heart is most frequently affected—all possible abnormalities having representation before the most frequent murmur of the right side. The reason for this is clear when we consider the vastly greater extent of tissues to be supplied by the left side of the heart compared with the pulmonary circulation supplied by the right.

The exocardial murmur is due to the movement of the heart rubbing two inflamed and roughened surfaces together. The pitch is usually high and quality squeaking. It has no connection with the valve sounds in time or location—is not transmitted in any particular direction and if loud, may be felt as a fremitus at the apex beat. It has no influence on the pulse curve.

The Pulse of Mitral regurgitation:
(*a*) Compensated, is soft and often large.
(*b*) Uncompensated, is soft and short (celer.).
" " " " stenosis is small and soft (sometimes frequent and often irregular).
" " " Aortic regurgitation is quick, large, "shotty pulse" (and regular).
" " " " stenosis is small and long (tardus).
" " " Tricuspid regurgitation is venous.

There is a normal venous pulse. In time it precedes the arterial pulse, and may be said to alternate with it. It is caused by the auricular systole and the consequent stopping of the free current toward the heart.

The abnormal venous pulse is discovered most easily at the lower part of the jugular vein, and is synchronous with the arterial pulse, being due to the same cause, namely, the systole of the ventricles. This indirect current can be forced into the veins only when there is insufficiency of the tricuspid valve.

CHAPTER XIII.

PRESCRIPTION OF EXERCISE.

The main object of a physical examination is to learn as many facts concerning the physical needs and tendencies of the subject as possible in order to be able to advise him properly regarding his exercise and personal hygiene. Without being able to give exactly the measures of a perfect man or woman we must have a standard of form and development that is derived from a knowledge of anatomy and experience in observing the individuals that present the highest evidence of perfect health and power. We learn also in a negative way by a study of pathological cases. The persons of impaired health can usually be so classified in groups with common symptoms that certain physical signs will be found common to nearly all in the group. Then by a study of the history of these cases we can judge with some correctness whether the physical sign stands in the relation of cause or effect to the abnormal symptoms. For instance, if we group together all cases of organic lung diseases such as tuberculosis, chronic bronchitis, recurrent attacks of pneumonia, pulmonary congestion, emphysema, etc., and find that a very large per cent of the cases have in common poorly developed respiratory muscles, flat chests, sagging shoulders, etc., with no other common feature, we may properly conclude that a chest of this type is not favorable for the healthy activity of lung tissue and in no sense is it a model toward which we should endeavor to conform the flexible chests of our people.

But our inference might be very far from truth and untrustworthy if we did not also approach the subject

from a different line of study and reach the opinion in a positive way. We do this by grouping the individuals that have proved their ability for enduring prolonged mental and physical strain, the superior individuals of society, like Bismarck, Gladstone, Greeley, Webster, etc. If we find in this group the physical conformity of chest exactly opposite to our other group, we have added to our knowledge of what should be avoided, a type that may wisely be followed.

It is often a question how far the æsthetic sense may guide us in deciding as to a physical standard. The eye will ordinarily be pleased with the form that has scientific perfection. A well rounded and developed body is more pleasing than a lax, untrained one, but there may be sentimental and unjust standards of criticism, the result of faulty training in youth, that bias even our judgments of beauty.

This is seen everywhere in the world of fashion. A head of hair that is considered beautiful and becoming one season must be bleached or dyed to some other color in order to be "perfectly lovely" the next. This depraved taste that approves of a pale face and crooked spine in a student, and a narrow waist with constricted chest and pelvic displacements in a woman, must be educated up to the scientific and artistic standard. We must show in the gymnasiums that increased health means not only increased ability, but increased beauty, and that health is only a correct balance of functional activities. It cannot exist in perfection if one part is under-developed or over-developed.

This brings us to the first point in prescription. If we discover an abnormality of shape due to extraneous causes we should first prescribe the removal of these causes when possible. To forget this would be to give medicine to counteract a poison while permitting the

patient to ingest more of the deadly substance. In work with both sexes the matter of dress should be inquired into where we find any suspicious abnormality of shape. This is especially true of constrictions of the trunk. Boys will often wear a belt in imitation of some noted "slugger" or local "tough," or for other reasons known only to themselves. The injurious effects are the same as those seen in the case of corset-afflicted women—weak lumbar muscles, narrow loins, pendent abdomen, varicose veins, costal respiration, digestive ailments, etc.

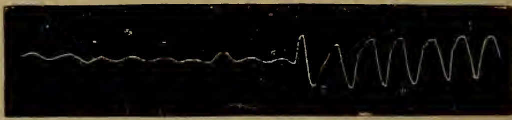
The muscular weakness cannot be cured while circulation is impeded by pressure on the fibres; the narrow waist cannot be brought out into correct outline, to give room for a proper location of the digestive organs, that would relieve the supra pubic distention, while every force is crowding them down into the pelvis.

The respiratory act should be unimpeded or imperfect oxidation will result and this means virtually an enforced vitiated atmosphere. A reduction of waist-girth by 50 mm. is shown by Dr. Sargent to reduce the lung capacity twenty per cent. A number of persons with an average lung capacity of 2.70 litres, and waist girth of 710 mm. were found to have a lung capacity of only 2.15 liters when the waist girth was reduced to 660 mm.

A reduction of the oxygen in the air by diluting it with nitrogen or carbon dioxide to the extent of twenty per cent would soon be disastrous to active life. Again, constriction of the waist calls for an entirely artificial method of respiration, as has been conclusively shown by Dr. Kellogg, through whose courtesy the following illustrations of normal and abnormal respiration are given on pages 184, 185.

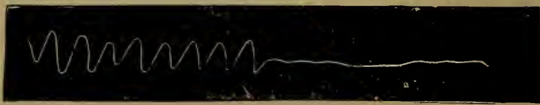
After looking at these illustrations, that explain themselves, two questions might be suggested by any person not fully acquainted with Anatomy and Physiology:

PLATE I.



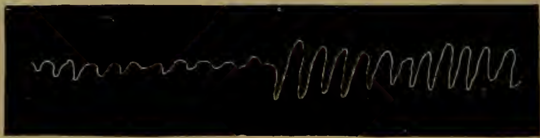
Costal. Abdominal.

Fig. 1. Man.



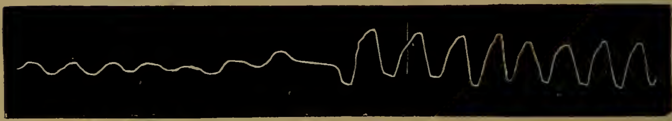
Costal. Abdominal.

Fig. 2. Civilized Woman (Unmarried, age 33 years).



Costal. Abdominal.

Fig. 3. Chinese Woman.

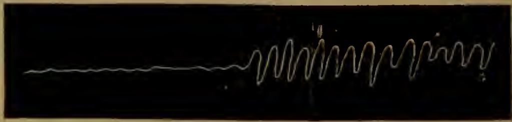


Costal. Abdominal.

Fig. 4. Indian Man (Chickasaw).

Costal. Abdominal.

Fig. 5. Indian Woman (Chickasaw).



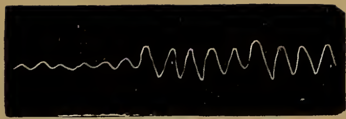
Costal. Abdominal.

Fig. 6. Chippeway Indian Woman.

PLATE II.

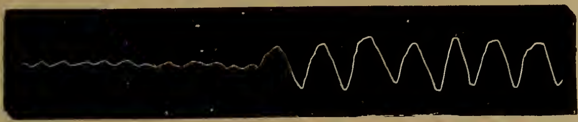
Costal. Abdominal.

14. Woman at Seventh Month of Pregnancy.



Costal. Abdominal.

Fig. 15. Woman, a Week Before Confinement.

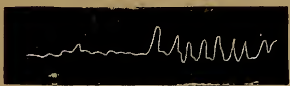


Costal. Abdominal.

Fig. 16. Man with Enlarged Spleen.

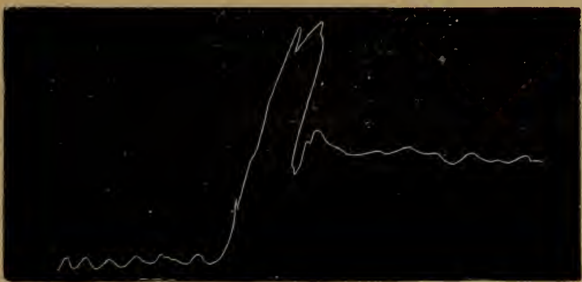
Ordinary. Forced.

Fig. 17. Respiratory Tracing (Vaginal).



Ordinary. Forced.

Fig. 18. Vaginal Tracing, with Corset.



Without Corset. Tightening Corset. With Corset.

Fig. 19. With and Without Corset.

First, Does not the amplification of the costal curves during compression show that the respiratory act is fairly complete—one set of muscles acting when the other is impeded? This view has been presented in articles by Dr. Mays, to which reference has already been made, who attempts to show that this method of breathing may tend to prevent tuberculosis by causing a better action of the apices of the lungs where that disease usually locates. The only support brought to this theory was the fact that more men than women die of pulmonary tuberculosis, but when we remember that this disease is largely due to climatic influences of which wide and sudden variations are the chief features, and that men are more exposed to these variations than women, the argument seems worthless.

But even if we concede a possible safeguard against tuberculosis in tight lacing we must still look upon it as a case where the remedy is worse than the disease, or a disguised blessing of the kind described by "Josh Billings," who remarked that "tight boots are a blessing, inasmuch as they cause a man to forget all his other miseries."

Second, If costal respiration is prejudicial to health why do we not have a larger death-rate from acute lung diseases and other diseases directly traceable to interference with respiration?

The reply is ready that the impaired activity of one organ rarely gives evidence in physical signs of its abnormality. Even as sensitive an organ as the brain may disclose its disordered function, not by pain in the head, but by the abnormal secretion in some remote organ; or a disease of the kidney be discovered by its causing an organic change in the heart. The lungs are ordinarily capable of enduring great hardship. Their flexibility enables them to conform to any shape of the thorax or

to be compressed for a long time by a pleuritic effusion, or other cause, without permanent injury as is frequently seen in cases of extreme kyphosis. According to the statistics of the New York Mutual Life Insurance Co., consumptives average one and a half inches less in chest girth than non-consumptives.

But meanwhile how fare the organs that are dependent on good blood? The brain cannot act well from the instant unoxidized blood flows in to supply it. Lowered vitality is the result with a yielding to acute diseases of every kind. Many a death is recorded as due to typhoid fever, peritonitis, malaria, etc., that is really due to a deficient respiration when the system requires the most active oxidation. The respiratory power is recognized as of the highest importance in all acute diseases.

The same care must be exercised in judging whether or not a bad form is due to faulty habits of posture. If the respiration is checked by a position that brings a bend in the trunk with a depression across the upper part of the abdomen, as is the case when one slides forward in his seat until the sacrum instead of the ischia bears the weight of the body, the same ill results will be found that are noticed in tight lacing. The horizontal depression due to the above cause will sometimes be found as high as the fifth rib, causing the "creased chest," and we can readily understand the interference with circulation that must exist in such cases. In all there will be more or less disturbance of the hepatic function, impaired digestion, constipation and atrophy of the lumbar muscles. Correct "form" while exercising is of special importance in these cases.

Attention was many years ago directed to the importance of the pelvic position, but comparatively few have undertaken a thorough study of what may be considered a normal tipping. If we take as the original position the

horizontal, we may measure by degrees of an angle the departure of the pelvis from this initial position, and thus record what is called the obliquity of the pelvis. An instrument, Fig. 36, for this purpose was first devised by Dr. Mosher and put into practical use.* In the article quoted she gives the results of measuring forty-one cases, twenty-three of which represented abnormal conditions, while eighteen represented perfectly healthy women. The table here reproduced shows that in every abnormal case the angle of obliquity was as small as thirty-four degrees, and in only one case was it over thirty-one degrees; while among the healthy women examined in no case was the angle less than thirty-seven degrees, and in nine it was as large as forty degrees. The averages were 28.3° and 40.1°, a suggestive variation.

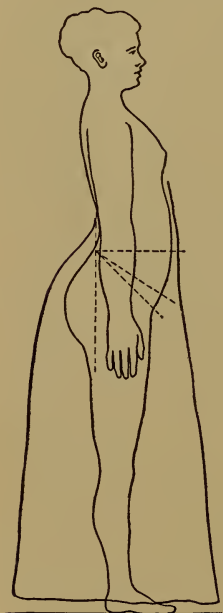


Fig. 68.

Dr. R. L. Dickinson of Brooklyn has studied the obliquity of the pelvis and his records coincide very closely with those taken by Dr. Mosher. Dr. J. H. Kellogg has also studied the importance of the pelvic obliquity, and has for many years laid great stress upon the necessity of such posture as shall secure a large obliquity. The outline of Fig. 68 is taken from a drawing made by him to illustrate normal healthy poise. The author has applied the lines representing the angular tip of the pelvis.

In early life the spine is essentially straight, the vertebræ being so related to each other that they represent a

* *New York Journal of Gynæcology and Obstetrics*, Nov., 1893.

slight curve with a concavity toward the anterior of the body. At this time the pelvis has its brim located essentially at right angles to the line of the vertebræ, the legs are drawn up and a comparative shortness of the muscles running from the anterior trunk to the thigh results. When the child begins to stand erect the leg must be extended from the trunk, which causes a stretching of the anterior groups of muscles, with a consequent increased pull upon the other attachments. The rectus femoris muscles, attached to the anterior superior spinous process of the ilium will tend to powerfully tilt the pelvis down in front, while the iliacus internus and the psoas magnus will act in the same manner, both running over the ramus of the pubic bone. While the young animal is creeping the weight of the abdominal organs is supported by the mesentery and the abdominal wall. When it assumes the erect position the weight is no longer largely supported by the abdominal wall, but must depend upon the mesentery and the floor of the abdominal cavity which will now be formed by the bony structure forming the pubic arch. If now the normal process in development of tilting the pelvis downward so as to form this solid support for the abdominal organs is arrested by any process, either rachitic or postural, the result will be that the floor of the abdomen will be the soft organs contained within the true pelvis, the pubic arch taking a position corresponding more nearly to the soft abdominal wall and forming a lateral support rather than a foundation. The hygienic result of this abnormal position will be obvious, and if we bear in mind that the hæmorrhoidal veins are not supplied with valves, we will understand that the position of the pelvic bones is of high importance in both men and women.

The muscular condition of the loins and abdominal wall can tell us much about the digestion and nutritive pow-

ers. If these muscles are weak we must point out the fact with emphasis and order such exercises as shall tend to give strength and activity to them. The small size of a man's biceps or gastrocnemius often troubles him when his real anxiety should be regarding his erector spinæ or rectus abdominalis. A person's arm will always be large enough for the ordinary demands of life upon it—his heart may not be; his leg will always be strong enough to fill every requirement—his stomach may fail utterly. A man may have life and fair health with complete loss of some muscles, while others act at the seat of life itself.

A class of cases will come under the care of the instructors in the gymnasiums of Schools and Colleges that will be rarely met by the Directors of other gymnasiums; a set of boys and girls who have been overworked mentally and underworked physically, until the nervous side of their lives is far in the ascendant. The whole idea of physical exercise has become repulsive to them because their muscular tissue is so weak that any fair activity begets great weariness, and sometimes even lameness. Brain work is easy for them because it has become the habit of their lives; they can generally accomplish great feats in the way of bearing severe strains of short duration, both mental and physical. They can sit up all night preparing for an examination, and the next day are bright and ready for good work, or, at the time of physical examination they show a surprisingly high record in strength tests, but come in the next day to tell of a strained back or lame shoulder as the result of their lifting. They make good athletes, but are continually getting over-trained. They invariably do too much.

Is gymnastic work advisable for such persons? An affirmative answer can only be given when there is to

be personal supervision of the work. The boy of high nervous organization needs exercise quite as much as one who has no tendency to abnormal nerve activity, but it must be of a different character, for the results sought are dissimilar. The nervous person does not live enough in his muscles. His habit is to make excursions out into his extremities, and after stirring them up and making every tissue tingle he retires, to leave each muscle exhausted and every energy depleted. The exercise prescribed for these cases, and enforced by personal supervision, must be light and continued over a long period of each day. To satisfy the mental requirement of the case the work must be made attractive, either as a game or a personal contest between individuals. In a few cases such an interest in the physical welfare can be excited in the subject as to take the place of this mental interest that is stimulated by games, and a person will do routine work that is laid out simply from the enjoyment that he gets from visible improvement.

Athletic work, on the other hand, is too stimulating to the nerve centers to be advisable for such cases. The excitement of contests will leave a person exhausted, for it will continually lead him to over-exertion. This objection does not apply to those contests where skill rather than great strength is the source of excellence.

Many of these persons, if uncared for in the gymnasium, would shortly fall into the hands of a physician as typical cases of neurasthenia, and rest must often be prescribed instead of exercise. The effect of sunlight on these neurasthenic cases is almost always favorable, and consequently outdoor work should be prescribed in preference to indoor work.

In marked contrast to the cases mentioned the athlete may be placed. Advice in regard to exercise will be sought, and such exercise must be prescribed as will tend

to secure a development of the muscles that are least used in the particular form of exercise in which the athlete engages. Again, after a severe course of training for any athletic event, many cases will find discomfort from local congestions on account of an over-activity of the heart during the period when there is no great physiological "wear and tear" to require a very active circulation. To meet these cases a course of training must be laid out that shall be graduated from heavy work down to light, so that the person may slowly accustom himself to the new conditions under which he must live. The heart of an athlete, who has been properly trained, is usually in good condition, and a very small percentage develop any heart lesion during their training, but a large over-strong heart may be an actual disadvantage to a man leading a sedentary life, as a puny, feeble heart surely is.

The examiner will find many cases of nutritive debility and nervous irritability. Among men a large per cent of these cases will be inordinate users of tobacco. The very first glance will betray to the experienced eye the "something wrong," but we must always remember that some of the most persistent users of tobacco are strong and hearty while a few of those who do not use it are weak and nervous. How then shall we say to a person who asks our advice whether he is suffering from nicotine poisoning or not?

In the first place the heart action under continued influence of nicotine is peculiar and attention is called to the sphygmogram, Fig. 69, of a typical pulse of

Fig. 69.

a "tobacco heart," from the Reference Handbook of the Medical Sciences. It will be noticed that the first two

beats are essentially normal with the tidal wave as marked as the dicrotic. The interval between the second and third waves is longer than the first which may be considered the normal for this case. The third interval is short and the dicrotic notch deep while the systolic wave is not high. The fourth interval is normal; the fifth longer and followed by a very faint impulse after which the heart again rallies, and so on.

The character of this pulse as felt at the wrist is irregular and tremulous. A beat or two of high tension followed by one of low, or there may be no rhythm discoverable.

These cases should be studied carefully and repeatedly to distinguish them from the frequent pulse of nervous excitement or the palpitation and irregularity of chronic indigestion. In perhaps three-fourths of the cases there will be some nervous excitement attendant on the new experiences of a thorough examination but this influence on the pulse may be either quickening or depressing, and these changes come during cycles covering many pulsations.

An intermittent pulse may not be an indication of serious interference with health or longevity and may not be due to any appreciable cause. The omission is then usually found at stated intervals not very short, but from ten to a hundred beats apart. It is not a condition to safely endure the hardships of athletic training but vigorous exercise may be prescribed.

Of course the examiner's duty is clear in each discovered case of smokers' irritable heart, and it is only suggested that other narcotic stimulants, like tea and coffee, will produce effects that are nearly similar. In these cases the exercise recommended must be light, and such as tends to relieve the circulation.

In studying the growth of a class in Yale it appeared

that if this growth be expressed in the form of percentage the weight of the non-users increased 10.4 per cent more than the regular users, and 6.6 per cent more than the occasional users. In the growth of height, the non-user increased 24 per cent more than the regular user and 12 per cent more than the occasional user. In growth of chest girth the non-user has an advantage over the regular user of 26.7 per cent and over the occasional user of 22 per cent, but in capacity of lungs, the growth is in favor of the non-user by 77.5 per cent when compared with the regular users, and 49.5 per cent when compared with the irregular users.

The matter of tobacco smoking as an influence upon the physical development of Amherst students has been studied in the history of the class of '91. Of this class, 71 per cent had increased in their measurements and tests during their whole course, while 29 per cent had remained stationary or had fallen off.

In separating the smokers from the non-smokers, it appears that in the item of weight the non-smokers have increased 24 per cent more than the smokers; in height they have surpassed them 37 per cent, and in chest girth, 42 per cent. And in lung capacity there is a difference of 8.36 cubic inches (this is about 75 per cent) in favor of the non-smokers, which is three per cent of the total average lung capacity of the class.

It has long been recognized by the ablest medical authorities that the use of tobacco is injurious to the respiratory tract, but the extent of its influence in checking growth in this and in other directions, has, I believe, been widely underestimated.

CHAPTER XIV.

THE EXAMINER HIMSELF.

And now a word in regard to the examiner himself: It is obvious that a medical training is of very great advantage to the person who is to make such physical diagnosis and measurement as shall be strictly scientific and accurate. If the examiner has not a medical education, let him always err on the safe side in a doubtful case and require a certificate from a physician before entering on a course of advanced exercise, or athletic work. But first let him study the case, using all the light that can be thrown on it from books and the history that can be obtained. The examiner must be a student, he must learn, he must study, examining not only the client but books, papers, periodicals. Anything bearing on his subject should be studied and questioned, but not criticised until he is sure of some error; then let him correct the error by showing its inaccuracy of fact or logic.

The examiner must have a thorough knowledge of anatomy and physiology, for in no other way can he become competent to advise a person regarding either health or exercise. To prescribe the same exercise for a person whose system is starved by malnutrition that we would for a person suffering from plethora would obviously be productive of unsatisfactory results both to the pupil and to the teacher. It must be remembered that malnutrition may be due to any one of several causes, and that while some of these will be removed or alleviated by exercise, others might be seriously aggravated. We must know how the machine is constructed and under what conditions it can work

most favorably before we can rightly attempt to adjust its mechanism or interfere with its ordinary working.

It is no longer a question of understanding Physiology that we may be able to care for the sick—we must know it, that we may understand the law of normal action for every organ and that harmonious inter-relation of all that constitutes health. Health is of more consequence than sickness, for it should be the constant condition of life varied only by the accidents to which all are subject.

Science has taught us that in living organisms functional activity must be kept up or there will be no development. A group of organs unused will atrophy and become useless. Heredity soon stamps a deformity, that has been developed in two or three generations, as a type, and succeeding generations that do not possess that peculiarity are looked upon almost as new varieties. This is especially true of physical defects that impair the vitality of the parents. Notice the stress laid upon this law by life insurance companies where business interests have no bias from sentiment. The excellent health of the applicant is not enough if there be a record going back two or three generations of degenerative diseases that have proved fatal, or if the constitutional vigor has been so weak as to let the life go out at about forty-five or fifty years of age from any immediate cause.

The first lesson that we must learn from this truth is, that health cannot exist if vital organs are seriously undeveloped.

Health is the condition of harmonious adjustment of *all* the functional activities. For instance: a normal pulse rate is from 72 to 76 beats per minute under ordinary conditions of rest, but a pulse-rate of 72 after a half-mile run might be considered abnormal and the ground for solicitude—for health would demand an increased activity of the heart muscle to supply increased blood

currents to the active muscles, that waste products may be eliminated and restorative elements supplied. But further: an adjustment of the pulse rate is not all that is to be required in the case cited, for there must be a corresponding increase of respiration for elimination and oxidation. And so the perfect activity of any organ—even the brain—may be shown to be dependent on the healthy activity of other organs, while the converse may be stated as a physiological truth, viz: that the imperfect action of any organ impairs the function of all others to some extent. A healthy muscle is, then, dependent on a healthy stomach, heart and brain, no less than on good food, air, etc., while the more refined intellectual processes are also based on a normal condition of the physical organs.

So practical a business man as the Hon. Thomas G. Shearman says: "I do not underrate the value of pure mental training, especially as that is nearly all which I have myself received; but my very lack of training in physical labor has led me to observe the great value which it has not merely with reference to bodily health and strength but for the very purpose of enlarging the *mental faculties.*"*

A system of education that has in view the symmetrical relations of mental and physical qualities, cannot ignore the necessity of beginning physical training with the mental. The child should come under the care of an experienced instructor in physical training from the day of entrance to regular school life. A physical examination should be made that should determine the condition of heart, lungs, spine, muscles, skin, eyes and ears. Many a case of incipient disease that eventuates in disaster, would be discovered, and put in the care of a physician, if necessary, or a correct regimen inaugurated with the aid of the parents, that would counteract the ten-

* Rep. of 3d annual meeting of Amer. Econ. Assoc., Phila., 1889.

dency to disease or deformity and save the child as a useful member of society.

To undertake this important duty will be the function of the physical director and the preparation should be careful and constant. Let no teacher look upon his position as a sinecure. There is work to be done in every field.

Do not permit the self-satisfaction of conceit to spoil your ability for work.

Do not take the statement of anybody as infallible. If it clashes with your own idea examine it and decide who is wrong.

Do not run after everything new and think that the new apparatus will make exercise a pleasure and relieve you of your work, or the new idea will save you the trouble of thinking.

Do not go through your work in a perfunctory sort of a way, but be enthusiastic and full of interest in those with whom you come into the relationship of adviser and instructor.

Be earnest, careful and exact, filled with the spirit of hard work, or move on to some less onerous occupation.

Do not try to find some fault with each person who comes under your care, nor continually decry habits that you believe to be bad. If you believe, as I do, that the use of tobacco is injurious to the majority of smokers, do not tell every person whose breath, "gives him away," that he is "killing himself" by smoking, or that he has the "smoker's heart" and must reform at once if he wishes to rob the grave of an early victim; for in every such case either you will be informed that the smoker has no desire to go into the business of robbing graves or you will be set down as a bigot whose opinion is good for nothing, and whose advice is worth still less. If a person asks you if you think tobacco has hurt him, and you find no indication of injury, be honest enough to tell him

so, and your candor will so establish his confidence in you that the subsequently expressed opinion, that tobacco has done him no good, will be likely to set him to thinking. At times you are expected to express yourself freely, as when lecturing on any subject, but do not try to pour a lecture into the unwilling ears of everyone who may chance to fall into your hands. You do no good but make yourself ridiculous.

Establish a record for honesty and ability and your advice will be sought. Integrity is the largest factor in influence.

Endeavor to find out the actual condition of each organ and do not be too quick to decide on the cause of any abnormality. If the heart action is imperfect and the person uses tobacco remember that there are occasionally "bad" hearts in those who have never "used the weed." A lateral curvature of the spine also may be due to no muscular inefficiency or weakness but may indicate good muscular action, as in case of a shorter leg on one side.

Do not be boastful and proudly claim to have discovered a new "system" or a "natural" system of exercise because you have by a certain method of life acquired a large biceps or general good physique. Your size of arm may have as little relation to any *system* as your size of hat. Because Dr. Tanner lived forty days without food he did not establish a system of living without food, and because some "Prof." can live comfortably by breathing only three times a minute it does not follow that he has a "system" all his own; a turtle can live all winter on one breath.

Be conservative and at the same time progressive. Examine all that is new, but before you adopt it test it by every standard that you can bring into comparison with it. Remember that you will probably not discover a great number of new truths, nor will you undermine

and overthrow many of the commonly accepted theories and doctrines that have been enunciated in the past.

Be modest, then, and learn much from others, claiming very little as entirely new and your own. At the same time it is well to remember that this science and art of Physical Education or Training is in its infancy, in this country at least, and there is much work that is experimental and tentative.

Perhaps in no field of scientific research bearing directly on practical medicine is more to be discovered and demonstrated than in kinetic physiology. The influence of exercise on muscle, bone, nerve and connective tissue is not fully understood—in fact we are only working at the alphabet of the science as it will be developed. Much injury to progress has been caused by superficial observation and extravagant claims for "systems" and methods that had produced fair results apparently with a select few and were then loudly proclaimed as a complete scientific exposition of the whole subject when they barely rested on a single correct principle or physiological truth. When the enthusiasm of the originator had died out the illumination was found to be meteoric and a general distrust was established.

A quack in a community injures the reputation of every honest practitioner in it. Be content, then, to work a great deal and claim very little. Have a scientific theory as a basis of your work but be ready to amend it at any time. Study your material and you will find so many facts to be classified and arranged that you will have little time to electrify the world by some universal specific. If you have no material and do not work you will have all the more time to invent some startling method that shall make you rich with the money of fools but leave science the poorer by a filching of her name and reputation.

BIBLIOGRAPHY.

AITKEN, WILLIAM. On the Growth of the Recruit and the Young Soldier. London, 1862.

AUDRAN, GERALD. Les proportions du corp humain mesurées sur les belles figures de l'antiquité. 1683.

BAXTER, A. M Statistics, Medical and Anthropological: Reports of the Provost-Marshal-General's Bureau, U. S.

BEARD, G. M. English and American Physique. N. Am. Rev., CXXXIX. 588–603.

BEDDOE, DR. JOHN. On the Stature and Bulk of Man in the British Isles. Mem. Anthrop. Soc., Vol. III.

BERTILLON, ALPHONSE. Les Proportions du Corps Humain. Revue Scientifique, 1889.

BEYER, H. G. Observations on Normal Growth and Development of the Human Body under Systematized Exercise. Report of the Surg. Gen. of the U. S. N., 1893.

The Growth of the U. S. Naval Cadets. Proc. of the U. S. Naval Inst., Vol. XXI.

BOAS, F. Anthropological Investigations in Schools. Pedagogical Seminary, 1891.

The Growth of Children. Science, Vols. XIX. and XX.

The Theory of Anthropometrical Statistics, pub. of the Am. Statist. Assoc., Dec., 1893.

Physical Characteristics of the Indians of the North Pacific Coast. American Anthropologist, 1891. IV. 25–32.

BOWDITCH, H. P. The Growth of Children. Report of Mass. Board of Health. 1877.

The Growth of Children. *Ibid.* 1879.

The Physique of Women in Massachusetts. *Ibid.* 1889.

The Growth of Children Studied by Galton's method of percentile grades. *Ibid.* 1891.

The Relation between Growth and Disease. Trans. of the Am. Med. Assoc. 1881.

BRADFORD, E. H. The Effect of Recumbency on the Length of the Spine. Bost. Med. and Surg. Jour., Vol. CIX.

BRINTON, D. G. External Mensuration of the Human Subject. Med. and Surg. Rep. XX. 1–2.

BRYAN, W. L. On the Development of Voluntary Motor Ability. American Journal of Psychology, Vol. V.

Dickson, S. H. Statistics of Height and Weight. Am. Jour. of Med. Sciences, Vol. LII., 1866.

D'Orbigny. L'Homme Americain de l'Amerique Meridionale. Paris, 1839.

Enebuske, Claes J. Some Measureable Results of Swedish Pedagogical Gymnastics. Proc. Am. Assoc. for Adv. Phys. Ed., 1892.

Foster, Alice. A Few Figures on Occupation. Rep. Am. Assoc. for Adv. of Phys. Ed., 1894.

Galton, Francis. Natural Inheritance. London, 1889.
Useful Anthropometry. Rep. Am. Assoc. Adv. Phys. Ed. '91.

Gihon, A. L. A Study of Adolescent Growth, etc. Report of the Surg. U. S. N., 1880.
Physical Measurements: Wood's Reference Handbook of the Med. Sciences, Vol. V.

Gould, B. A. Investigations in the Military and Anthropological Statistics of American Soldiers. Mem. U. S. Sanitary Com. 1869.

Greenleaf. New Table of Physical Proportions. Balt. Underwriter, 1890.

Gulick, L. Manual for Physical Measurements. 1892.
Value of Percentile Grades. Quar. of Am. Statist. Assoc. 1893.
Papers on Anthropometry. Phys. Ed., Sept., Oct., Nov., Dec., 1893; Feb., May, 1894; Jan., 1895.

Hall, W. S. The Changes in the Proportions of the Human Body During the Period of Growth. Journ. of the Anthropolg. Soc. of Gt. Britain and Ireland. 1895.

Hansen. Ueber die Individuellen Variationen der Koerperproportionen. Archiv. f. Anthropologie, Vol. XX.

Hartwell, E. M. Law of Growth and What It Teaches. Rep. Am. Assoc. for Adv. Phys. Ed., 1895.
Report of Director of Physical Training. Boston, 1894.

Hitchcock, E. An Anthropometric Manual, 1889.
Comparative Study of Measurements of Male and Female Students at Amherst, Mount Holyoke and Wellesley Colleges. Proc. Am. Assoc. for Adv. Phys. Ed., 1891.
The Results of Anthropometry as Derived from the Measurements of the Students in Amherst College. 1892.

Hitchcock, E., Jr. A Synoptic Exhibit of 15,000 Physical Examinations. Rep. of Pres. of Cornell Univ. 1889.
Summary of Averages. Proc. Am. Assoc. Adv. Phys. Ed., '90.
Physical Measurements, Fallacies and Errors. Proc. Am. Assoc. for Adv. Phys. Ed., 1891.

Hurd, Kate C. Some of Galton's Tests Concerning the Origin of Human Faculty. Proc. Am. Assoc. for Adv. Phys. Ed. 1891.

Jackson, W. S. Graphic Methods in Anthropometry. Phys. Ed. II. 1889–1894.

KEY, A. Die Pubertætsentwichelung. Verhandlungen der Zehnten International Med. Congress Zu Berlin. 1890.

MANOUVRIER. Bull. de la Soc. d'Anthrop. de Paris, 1890.

MOON, S. B. Measurements of the Boys of the McDonogh School for the Years 1888–1891.
How Boys Grow. Proc. Am. Assoc. for Adv. Phys. Ed., 1895.

PECKHAM, GEO. W. The Growth of Children. Rep. Wis. Board of Health, 1881–1882.

PORTER, W. T. The Physical Basis of Precocity and Dullness. Trans. St. Louis Acad. of Sci., 1893.
Growth of St. Louis Children. *Ibid.* 1894.
Useful Anthropometry. Rep. Am. Assoc. for Adv. of Phys. Ed., 1895.

QUETELET, A. Sur l'Homme et le Developpment de ses Facultés, 1846.
Anthropométrie, 1870.

ROBERTS, C. A Manual of Anthropometry. 1879.

SARGENT, D. A. The Physical Proportions of the Typical Man. Scribner's Magazine, July, 1887.
The Physical Characteristics of the Athlete. *Ibid.* Nov. 1887.
The Physical Development of Women. *Ibid.* Feb., 1889.
Anth. App. with Directions for Measuring.

SCHMIDT E. Anthropologische Methoden. Leipzig, 1888.

SCRIPTURE, E. W. Reaction Time. Rep. Am. Assoc. Adv. Phys. Ed.

STIEDA. Ueber die Anwendung der Wahrscheinlichkeiterechnung in der anthropologischen Statistik. Archiv. f. Anthrop., 1883.

STORY, W. W. The Proportions of the Human Figure, According to a New Canon, for Practical Use.

WEST, G. M. The Growth of the Breadth of the Face. Science. XVIII.
The Growth of the Body, Head and Face. Science. XXI.

WEY, H. D. Phys. Train. for Youthful and Dullard Criminals. Rep. Am. Assoc. for Adv. Phys. Ed., 1888.
Year Books—Elmira Reformatory, 1888–1896.

WOOD, M. ANNA. Anthropometric Table, Compiled from the Measurements of 1100 Wellesley College Students; Arranged According to Bodily Heights. 1890.
Statistical Tables Concerning the Class of 1891 of Wellesley College, Numbering 104 Women.